ORDNANCE

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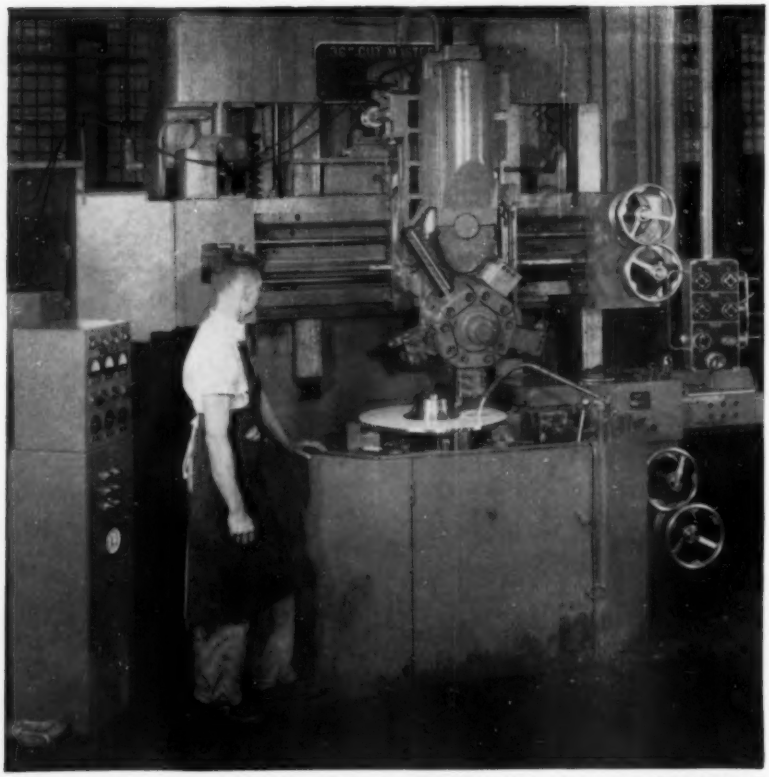
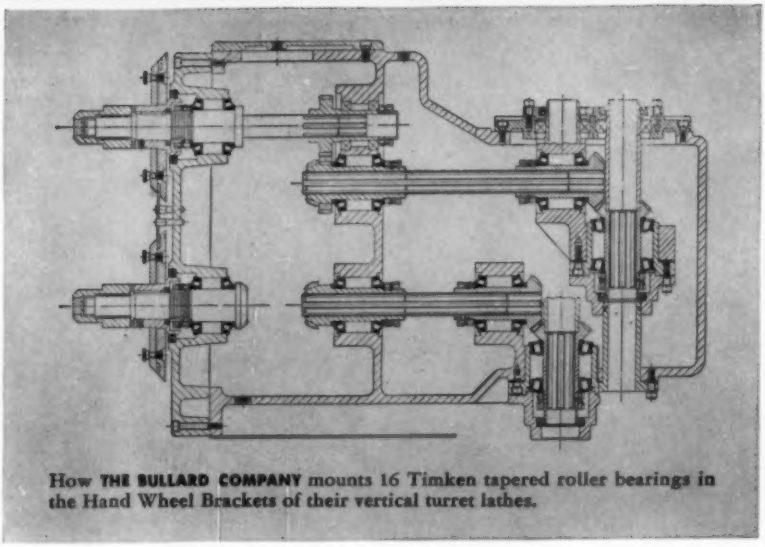
Tridimensional Attack

JANUARY-FEBRUARY 1957

TIMKEN® bearing equipped . . . 1 lathe replaces 4, cuts machining time 81%





How **THE BULLARD COMPANY** mounts 16 Timken tapered roller bearings in the Hand Wheel Brackets of their vertical turret lathes.

THIS new Bullard 36" Cut Master Vertical Turret Lathe, turning out hub discs and cover discs for turbo wheels at the York Corporation, York, Pa., has cut machining time an average of 81%. And does all the operations formerly done on 1 horizontal turret lathe, 2 engine lathes, and 1 older vertical turret lathe! Timken® tapered roller bearings play a major role in this production story.

16 Timken bearings in the hand wheel bracket—and other Timken bearings in the headstock and feed works—maintain precision, locate shafts and gears, hold integral parts in accurate alignment. Reduce wear.

Maintenance costs are low, with Timken bearings built to last the life of the lathe. Friction is practically eliminated, conserving power. Timken bearings are geometrically designed, precision-manufactured, to give *true rolling motion.* To insure highest quality, we even make our own fine alloy steel—which no other American bearing maker does.

Look for the trade-mark "Timken" on each bearing! The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

TRADE-MARK REG. U. S. PAT. OFF.

ORDNANCE

LAND · SEA · AIR

The Magazine of Scientific and Industrial Preparedness Now in Its 37th Year

VOL. XLI JANUARY-FEBRUARY 1957 NO. 220

The Cover.—*Marine Corps assault tactics make use of helicopter-mounted mobile units, amphibious personnel carriers, and lightweight recoilless-rifle artillery to establish a beachhead and exploit the advantages given by modern armament.*

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NOW . . .
TWO GREAT COMMANDERS IN THE SERVICE OF THE U. S. AIR FORCE

The L-26B and the Supercharged L-26C are designed and produced by the manufacturers of Aero COMMANDER Model 560-A and Model 680-Super —twin-engine executive transports in the service of business and governments around the World.

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Compressor mufflers with four, five, and six tubes carry refrigerant from the suction side of the system to the compressor. Bundyweld Tubing and skilled Bundy engineering can solve your tubing problems, too. Try us.

To hush a refrigeration compressor, Bundy helps design a "pipe organ"

Refrigeration compressors are quiet—but not quiet enough for one leading manufacturer. With an assist from Bundy®, the producer developed this "pipe organ" muffler. Now, multiple tubes mounted on a special header carry refrigerant from evaporator to compressor without a murmur.

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. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
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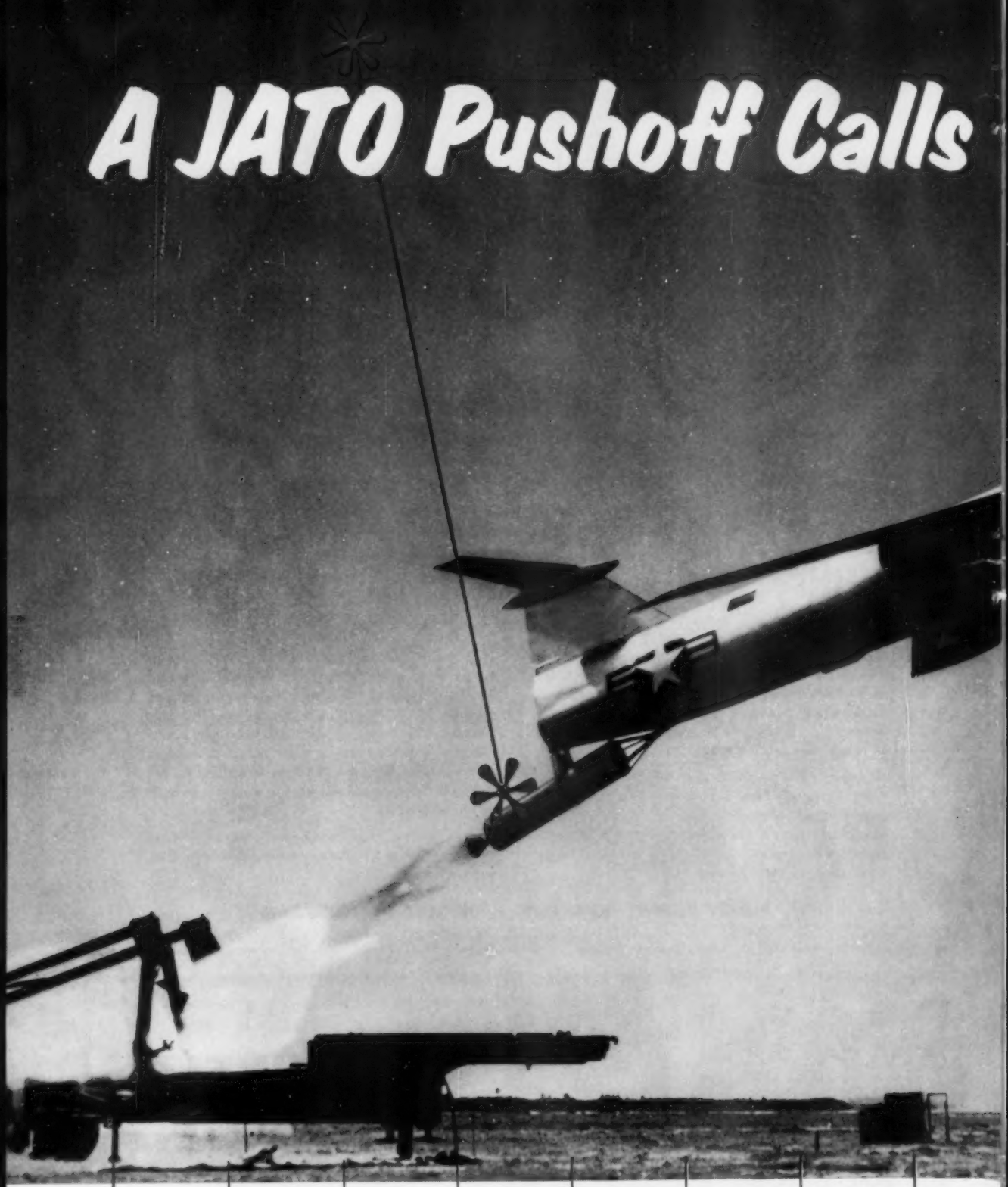
NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP

A JATO Pushoff Calls



practice bombs

mortar shells

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land mines

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aircraft parts

*Photo of TM-61 Matador courtesy of the Martin Co.

For... PRECISION

That's why this JATO comes from PARISH

JATO bottles have to be precision made. Intense pressures build up inside them as their propellant charge burns out. They've got to be correct structurally, too, because the entire force they generate—enough to heave 12,000 lb. missiles to flying speed from a standing start—is concentrated in one very small area.

Parish Pressed Steel is one of the first companies to successfully mass produce these big, precision JATOS. The reason: Parish has exactly the unique combination of engineering experience, production know-how and special equipment needed for such critical work.

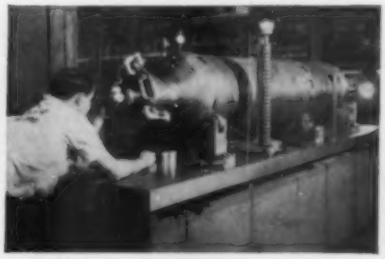
In other words, Parish has the ability to get ready for production fast, produce in volume by the most modern mass production methods, and still work with the tightest tolerances . . . within almost any delivery requirements you care to make.

Parish facilities cover the full range of metalworking . . . machining, welding, forming, heat-treating. They're available for additional work right now. Call or write for detailed information.

WELDING. Parish precision fixture turns preheated (600° F.) tube as submerged arc accurately welds nozzle to motor tube.

HEAT TREATING. Crane lifts hot (1600° F.), hard-to-handle JATO bottle from furnace into specially built tank for simultaneous internal-external quench.

FINAL MACHINING. Special lathe fixture holds 8-foot-plus bottle for precision finishing of nozzle after pressure tests are completed.



INSPECTION. Precision optical gages are used for highly critical inspection of completed JATO.

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CPT Liquid Springs provide high load absorption within the minimum space available on this razor-wing aircraft. Over 70,000 test cycles proved the reliability of the liquid spring principle.

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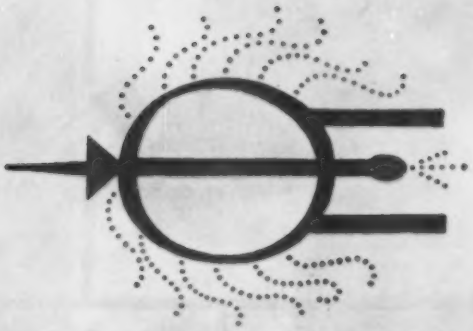

صفة بيضة تخرج وتخرق

er-Rammah's self-moving egg

Join two flat pans; fill with an incendiary mixture; add a tail; propel by two large rockets. In A.D. 1280, Arabia's Hassan er-Rammah, gazing centuries ahead, proposed this ovoid in his "The Book of Fighting on Horseback and with War Engines."

Today, rocket-powered ordnance is foremost in American defense...and Aerojet-General Corporation is foremost in rocket power. Aerojet's solid-propellant rockets are used on the Sparrow and Regulus and on the newest, most advanced American missiles.

Aerojet-General CORPORATION

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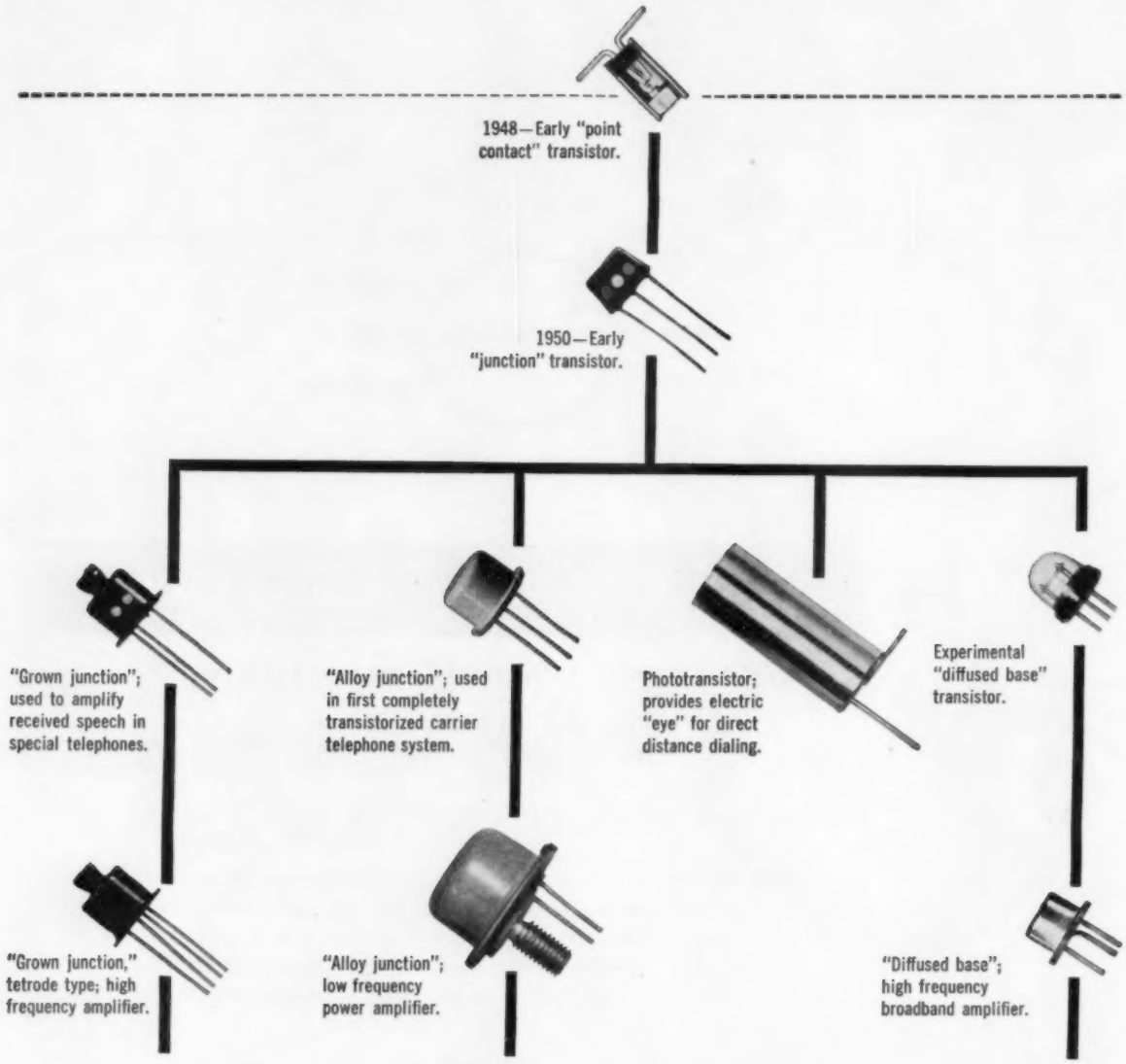
PLANTS AT AZUSA AND NEAR SACRAMENTO, CALIFORNIA

TRANSISTORS—first family of electronics


1948—Early "point contact" transistor.
1950—Early "junction" transistor.
"Grown junction"; used to amplify received speech in special telephones.
"Alloy junction"; used in first completely transistorized carrier telephone system.
Phototransistor; provides electric "eye" for direct distance dialing.
Experimental "diffused base" transistor.
"Grown junction," tetrode type; high frequency amplifier.
"Alloy junction"; low frequency power amplifier.
"Diffused base"; high frequency broadband amplifier.

In 1948 Bell scientists announced their invention of the transistor—a tiny device able to amplify signals a hundred thousand times using a small fraction of the power of an electron tube.

From this original "point contact" transistor has grown a distinguished family of immense usefulness to electronics. Some of its leading members are shown here, in approximate actual size, with their scientific type names.

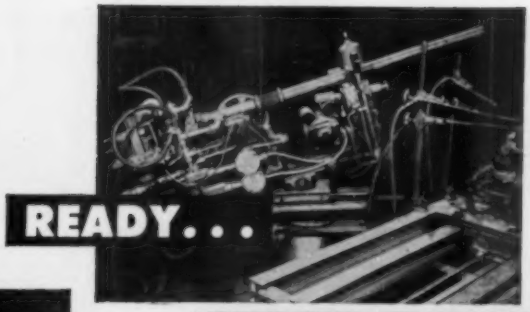
For telephony the transistor has opened the way for notable advances in instruments, transmission and switching. Elsewhere it has opened the way to advances in hearing aids, television, computers, portable radios and numerous military applications.

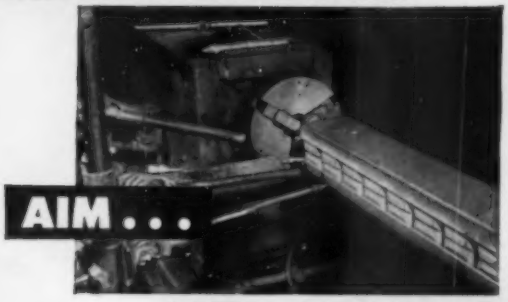
Bell's transistor family is typical of the Bell Laboratories research that helps keep your telephone service the world's best—and at the same time contributes importantly to other fields of technology.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

LINDE's Flame-Plating gun is operated entirely by remote control. At control panel (below) is operator, who observes process through safety-glass window. At right, Flame-Plating gun is seen as workpiece is secured in fixture (top), as gun is brought into range (center), and at the instant of a blast in the plating action (bottom).





Not all guns shoot BULLETS ...this one gives metal parts EXTRA WEAR RESISTANCE

A dramatic and useful coating process for metal parts has been developed by LINDE engineers to provide extra resistance to wear and abrasion. This method, called Flame-Plating, utilizes a special, rapid-fire gun to apply an extremely hard coating of tungsten carbide or aluminum oxide on precision parts subject to unusual wear or fretting corrosion.

The Flame-Plating gun consists of a barrel and a mechanism for loading precise amounts of powdered coating material and explosive gases into a firing chamber. The powder—tungsten carbide or aluminum oxide—remains suspended in the gases until a controlled spark ignites the mixture.

The resulting detonation creates heat and pressure waves of tremendous force. These waves rip through the gas-and-powder mixture at supersonic velocity. The particles are hurled against the work with terrific impact. They fuse together and build up until the desired thickness is obtained.

The temperature of the workpiece seldom exceeds 400 degrees F. Thus precision parts can be Flame-Plated without risk of changes in physical dimensions or metallurgical properties. Coatings can be Flame-Plated in thicknesses from .002 to .010 inch, and finished to 0.5 microinches rms. Practically all metals can be Flame-Plated.

The extra resistance of Flame-Plated parts to wear, abrasion, and fretting corrosion has been proved in actual service. Vital parts in aircraft and automotive power plants, hydraulic systems, and heating units, as well as textile and canning machinery, plug and ring gages, bearings, and seals have all had their useful life greatly extended—and economically, too—with Flame-Plating by LINDE. Find out how Flame-Plating can help you improve your own design. Write for a free copy of the booklet, "Flame-Plating," F8065. Address "Flame-Plating, Department O-1."

LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, New York

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto

The term "Linde" is a trade-mark and FPL is a service-mark of Union Carbide and Carbon Corporation.

Flame-Plating by Linde

BREAKING THROUGH THE HEAT BARRIER

The faster they go, the *hotter* it gets inside guided missiles and jet aircraft. The heat comes from friction of air and from electronic equipment.

Heat from friction cannot be eliminated, but heat from electronic equipment can be greatly reduced by using transistors. However, existing transistors could not be used because they would not operate at high enough temperatures. Now, Raytheon's new PNP silicon transistors function reliably at high temperatures in jet and missile equipment—give 90% savings in size, weight and power.

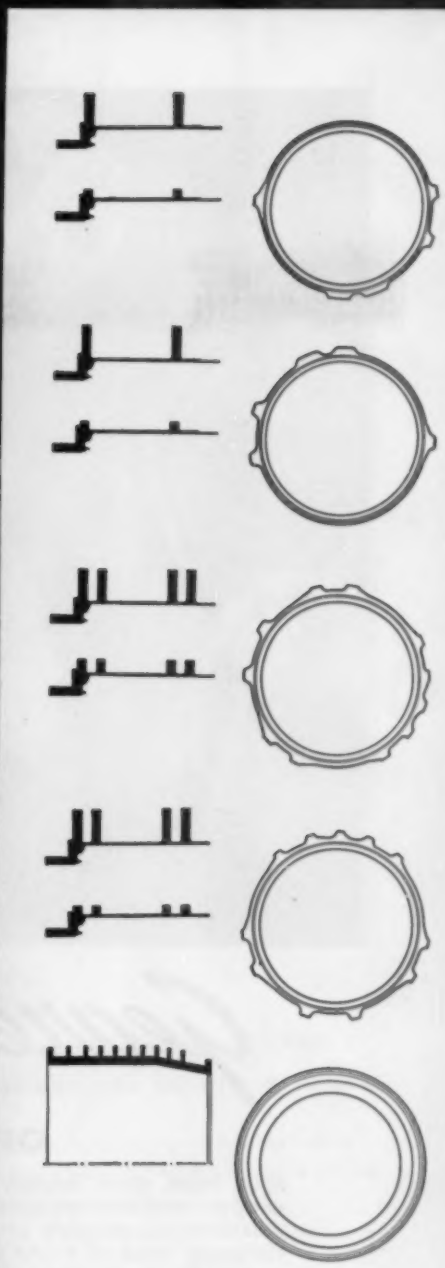
By helping to solve this difficult problem, silicon transistors by Raytheon are making a significant contribution to the efficient operation of the latest airborne military equipment.

There are more Raytheon transistors in use than any other make.

Excellence in Electronics

RAYTHEON

RAYTHEON MANUFACTURING COMPANY
Waltham 54, Massachusetts



Typical ring sections and profiles showing lug configurations in a smaller scale.

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One of Cameron's most interesting contributions to military and commercial air-power today is the production of forged, stainless steel, stator rings. Our unique processes make possible precision forgings with odd lug configurations, large diameters and a vastly superior grain structure. Shapes and sizes heretofore costly to produce as a forging are now sound economy at Cameron.

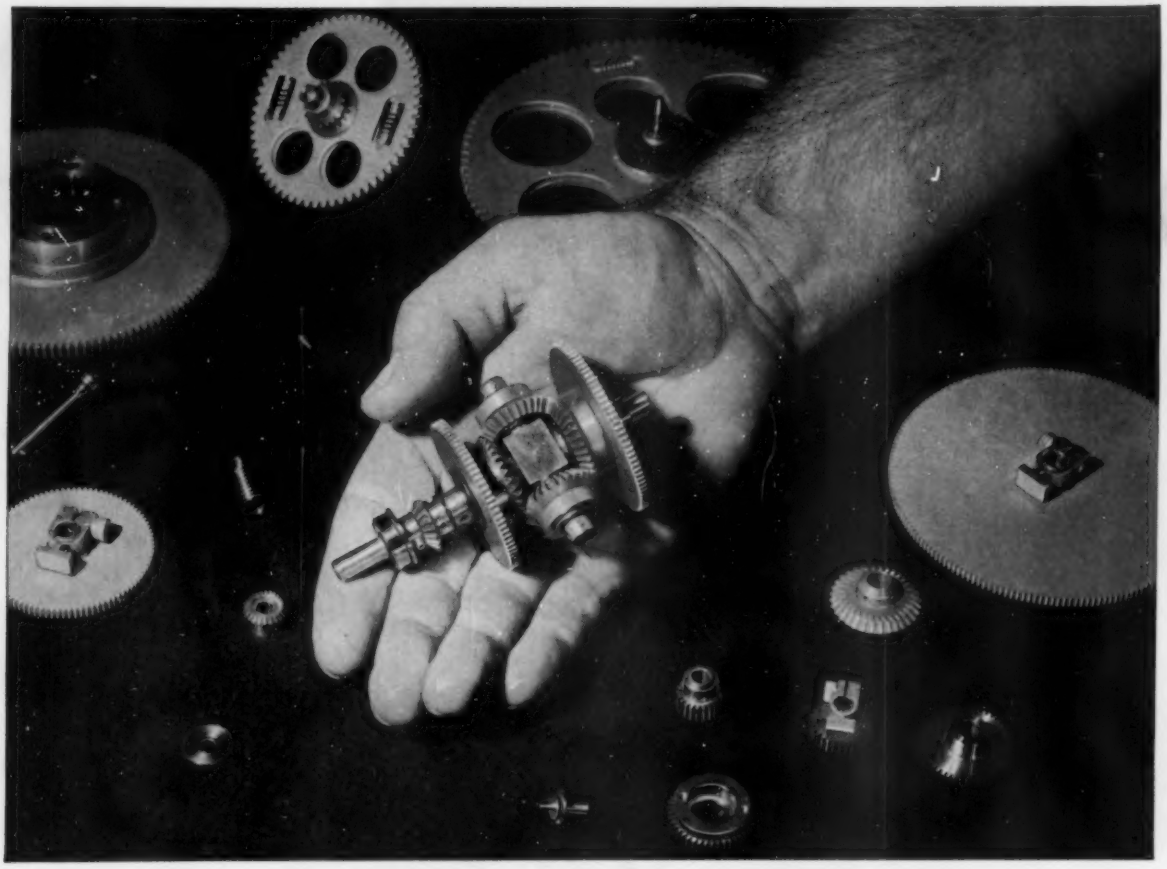
The study of specialized alloys to meet the extreme demands of today and to anticipate those of tomorrow parallels forging production and is a part of our progress.

Investigate these advantages — write or call.....

Cameron

IRON WORKS, Inc.

SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas



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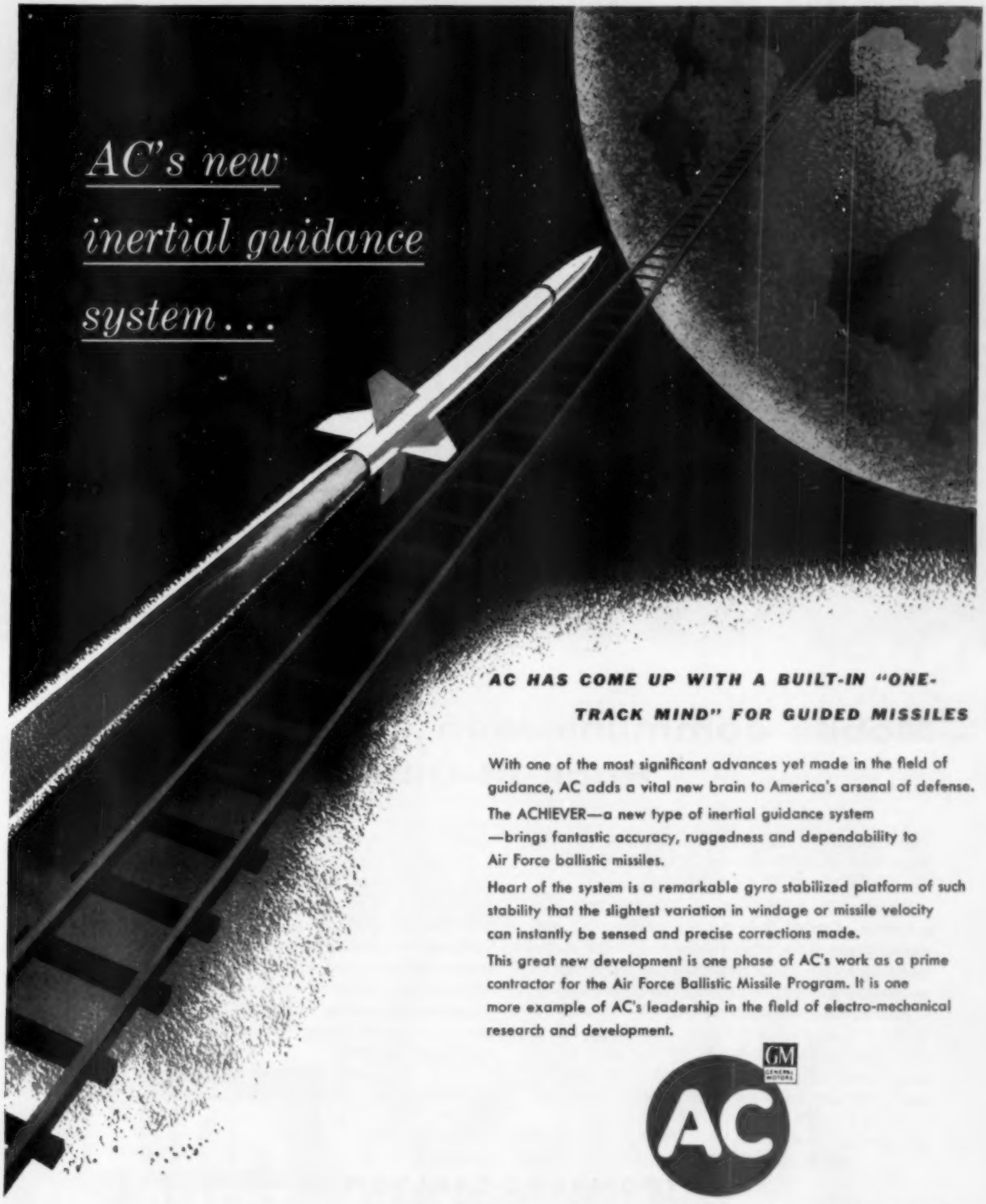

AC HAS COME UP WITH A BUILT-IN "ONE-TRACK MIND" FOR GUIDED MISSILES

With one of the most significant advances yet made in the field of guidance, AC adds a vital new brain to America's arsenal of defense.

The ACHIEVER—a new type of inertial guidance system —brings fantastic accuracy, ruggedness and dependability to Air Force ballistic missiles.

Heart of the system is a remarkable gyro stabilized platform of such stability that the slightest variation in windage or missile velocity can instantly be sensed and precise corrections made.

This great new development is one phase of AC's work as a prime contractor for the Air Force Ballistic Missile Program. It is one more example of AC's leadership in the field of electro-mechanical research and development.

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AC

THE ELECTRONICS DIVISION OF GENERAL MOTORS

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Mobile communication . . . Rock-of-Gibraltar type

The short-wave radio transmitter and receiver illustrated above is known as GRC-19, and we build it for the U. S. Army Signal Corps.

Satisfactory production of such equipment is a matter of more than precise engineering and manufacture. Two other things contribute to the fact that a very large percentage of our facilities is devoted to making products for the military.

First is *environmental testing*. The Stromberg-Carlson Test Center provides 'round-the-clock, seven-days-a-week service in life test areas which range from vibration tests simulating air-borne and vehicular transportation to work in jungle humidity or stratosphere sub-zero.

Second is *cost-watching*. Under a research and development contract aimed at reducing costs of communication gear, we designed a model of the AN/GRC-19, eliminating some of the automatic features, and costing substantially less than the automatically tuned model. This new set, the AN/GRC-65, will serve in those field applications where manual tuning is satisfactory. Our government is a shrewd buyer. We're proud to have its patronage so often.

There are plenty of career opportunities here for Engineers . . . Why not write us?

STROMBERG-CARLSON COMPANY

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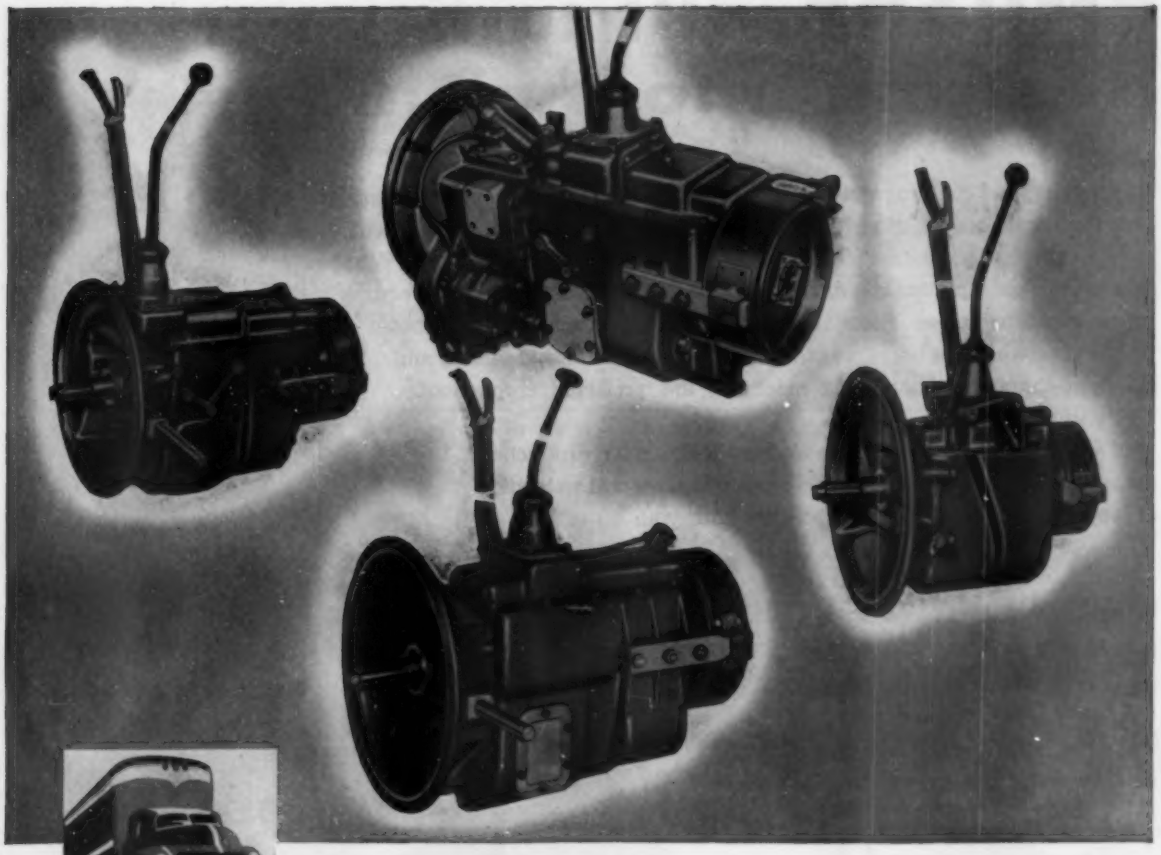
General Offices and Factories at Rochester, New York — West Coast plants at San Diego and Los Angeles, California



POWER TRANSMISSION?

start from scratch . . . WITH CLARK

It's a far cry to days when a transmission was an individual component—a set of gear ratios in a box.

Today it's a vital member of a power-transmission team, engineered to perform a specific assignment in a vehicle that works for somebody's living: a highway hauler, a bus, or an off-highway machine.

Talk to Clark.

Have you a new model in the drafting stage?—or an existing one in need of face-lifting? Clark either has a unit to meet your need, or can design one—from transmission to complete power train.

Here is a full half-century of operating experience in that vital area *from engine flywheel to point of torque application.* That fund of knowledge is yours to command.

Talk to Clark. A handy-sized booklet tells what products Clark manufactures; explains, also, why many leading vehicle builders call it "good business" to do business with

CLARK®
EQUIPMENT

CLARK EQUIPMENT COMPANY
TRANSMISSION DIVISION
JACKSON 12, MICHIGAN

EMHART will turn your designs into machines

Engineering and building automatic machinery is Emhart's primary business. The four divisions produce more than 275 different machines as standard items and have a combined manufacturing experience of nearly 200 years. Henry & Wright makes high speed automatic dieing machines; V & O builds, tools and equips precision power presses. Standard-Knapp's packaging machinery is known to everyone who uses boxes, bags, cans or bottles for their products, and Hartford-Empire's glassmaking machines are preferred throughout the world.

If you have a machine design and are looking for experienced manufacturing facilities to handle production, we will welcome an opportunity to discuss our facilities with you.

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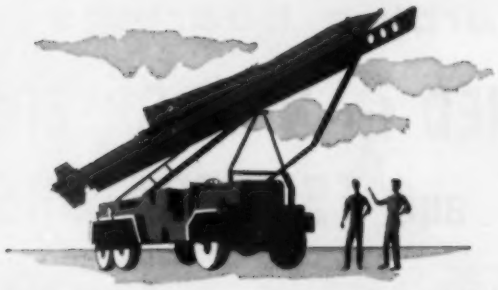
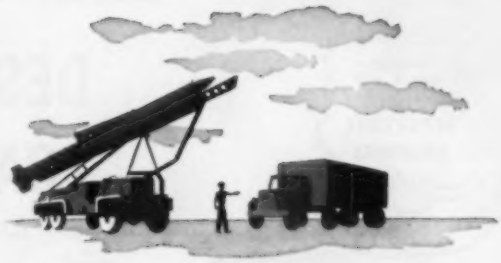
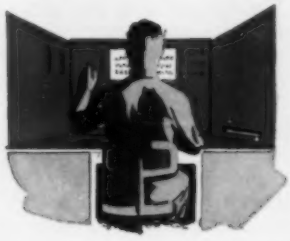
Automatic, High Speed Dieing Machines & Special Machinery



1002 Before launching this missile hundreds of tests must be made — a process usually requiring several hours and highly-trained technicians.

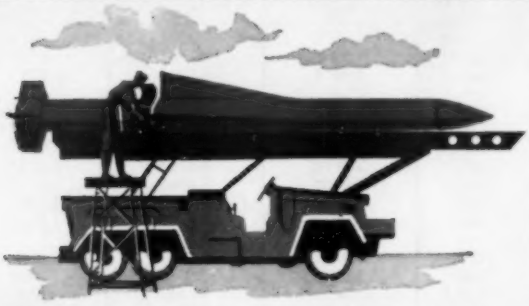


1003 Sperry Check-Out Equipment built into truck is readily moved to launching area to handle all tests.



1008 Inside truck the operator sits at console and by merely pressing button sees micro-filmed information for operational decisions on each malfunction.

1009 Pressing another button operator receives card showing adjustment or repair required and detailed instructions.



1025 With complete instructions for repairs, the check-out is rapidly and accurately completed.

1030 Missile is launched with assurance that its complex mechanisms are operating properly.

SPERRY AUTOMATIC CHECK-OUT EQUIPMENT

Keeps Weapons Fit to Fight

Saves time, cost . . . requires no highly trained personnel

• Keeping a weapon system operable at all times requires complex testing and evaluating. With Sperry Automatic Check-Out Equipment, this procedure can be simplified . . . time reduced to a minimum.

• *Complete* system test can be made most economically and without highly trained personnel. This includes electrical, hydraulic, pneumatic, stabilization, guidance, arming and propulsion components.

• Our Microwave Electronics Division can solve your problems in weapon systems' evaluation.

MICROWAVE ELECTRONICS DIVISION

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FACTS about NEW DEPARTURE BALL BEARINGS

aircraft turbine bearings . . .

DESIGNED for HIGH SPEEDS, LOADS and TEMPERATURES

New Departure split inner ring bearing mounting for jet engine main shaft

Today's leading production jet engines turn on New Departure split inner ring bearings . . . an out-ahead development of New Departure's continuing Aircraft Research Program.

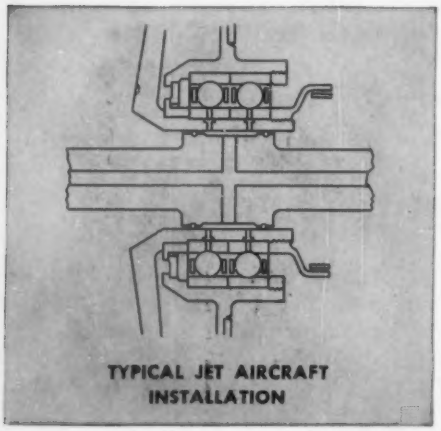
These turbine bearings handle heavy thrust loads from either direction and major radial loads with unexcelled dependability. Two-piece inner ring construction facilitates cleaning, inspection and assembly. It also permits use of the maximum number of balls of largest possible diameter with high thrust shoulders and one-piece separator construction.

While these bearings meet today's demand, tomorrow's needs command the facilities of the New Departure Aircraft Research Program. Already bearing development looks ahead to operational speeds in the order of 100,000 rpm and temperatures close to 1000° F. Write for New Departure's Aircraft Turbine Ball Bearing Folder TB-56. New Departure, Division of General Motors, Bristol, Connecticut.

MEDIUM and LARGE TURBINE BEARINGS

Basic Bearing No.	NOMINAL DIMENSIONS		
	Bore	O.D.	Width
LL34	6.6929	9.0551	1.102
LL36	7.0866	10.2362	1.614*
LL44	8.6614	12.5984	1.929*
L22	4.3307	7.0866	1.280*
L24	4.7244	7.4803	1.280*
L26	5.1181	7.8740	1.280*
L28	5.5118	8.6614	1.574*
L30	5.9055	8.5060	1.235*
L32	6.2992	9.4488	1.338
L34	6.6929	10.6299	1.815*
207	1.3780	2.8346	.669
209	1.7717	3.3465	.938*
212	2.3622	4.3307	.866
213	2.5591	4.7244	.905
214	2.7559	5.1181	1.023
215	2.9528	5.1181	1.181*
216	3.1496	5.5118	1.023
219	3.7402	6.6929	1.259
220	3.9353	7.0886	1.385*
222	4.3307	7.8740	1.771*
224	4.7244	8.4646	1.850*
228	5.5118	9.4488	2.007*
232	6.2992	10.1992	1.660
307	1.3780	3.1496	.826
315	2.9528	6.2992	1.456

*Puller groove, inner ring or both rings



TYPICAL JET AIRCRAFT INSTALLATION

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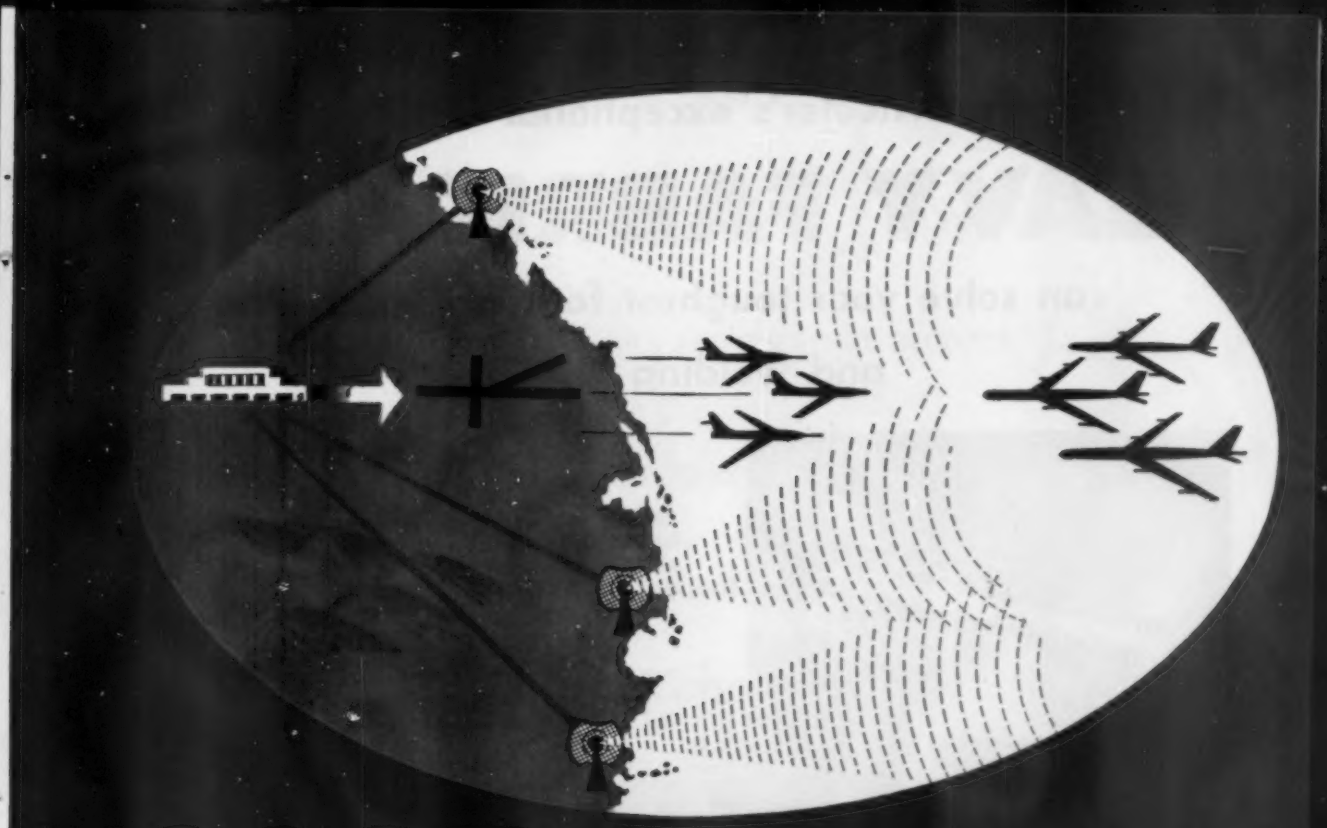
NEW DEPARTURE BALL BEARINGS

GM GENERAL MOTORS

NOTHING ROLLS LIKE A BALL

BALL BEARINGS MAKE GOOD PRODUCTS BETTER



SAGE

SEMI-AUTOMATIC GROUND ENVIRONMENT

speeds security . . . with the help of Burroughs computation

Briefly, SAGE does this: employs radar and electronic digital computers to detect and identify approaching enemy aircraft; determines appropriate defensive measures such as antiaircraft weapons, missiles, or intercepting planes; guides missiles and interceptors to the target and then returns planes to their home base.

Burroughs has the SAGE job of helping to speed the correlation and translation of warning data through automatic computation. This entails research, development, prototype design and engineering, production, installation, training and field maintenance.

Here is just one of many significant Burroughs contributions to defense in the areas of instrumentation, control systems, communications, electronic computers, data processing. And on the basis of our proved skills, facilities and experience, we welcome further inquiries regarding defense contracts. Call, write or wire Burroughs Corporation, Detroit 32, Mich.

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Looking to future expansion, Burroughs invites inquiries from qualified engineers.

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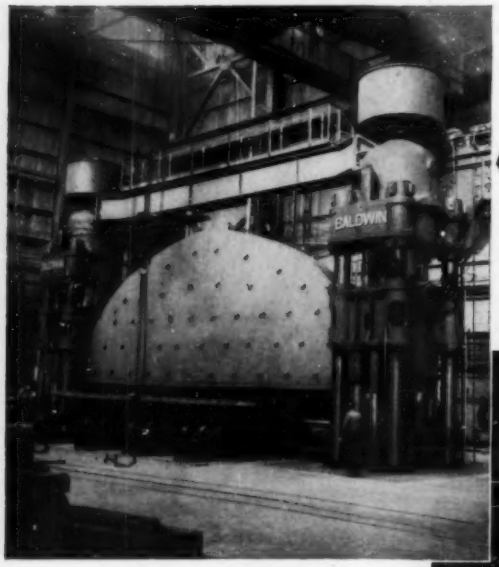
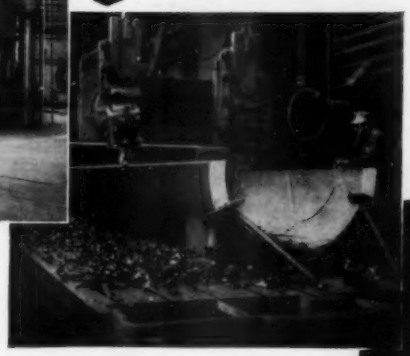
HEAVY FABRICATION

can solve your toughest forming, machining and welding problems



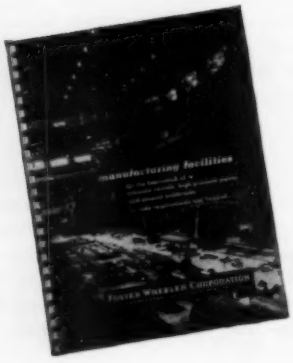
This huge, 8000-ton hydraulic beam press easily performs bending and forming operations on steel plates up to 9 inches thick and 39 feet in length.

Here, on one of the largest double housing planers in the country, welding grooves are machined in one half of a cylinder for a large pressure vessel.



Twin arc automatic submerged arc welder joins two longitudinal half shells for a 6-inch thick pressure vessel.

With four large and exceptionally well equipped plants — at Carteret, N.J., Mountaintop, Pa., Dansville, N.Y. and St. Catharines, Ontario — Foster Wheeler offers a unique fabricating service to industry. High-pressure vessels, heavy-wall pipe and unusual weldments to Code requirements and beyond, as well as your lighter fabrications, can be produced by the most modern and efficient methods, with substantial savings in time and cost.



For More Complete Information on Foster Wheeler fabricating facilities, send for your copy of our new, 20-page Bulletin No. GS-56-4. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

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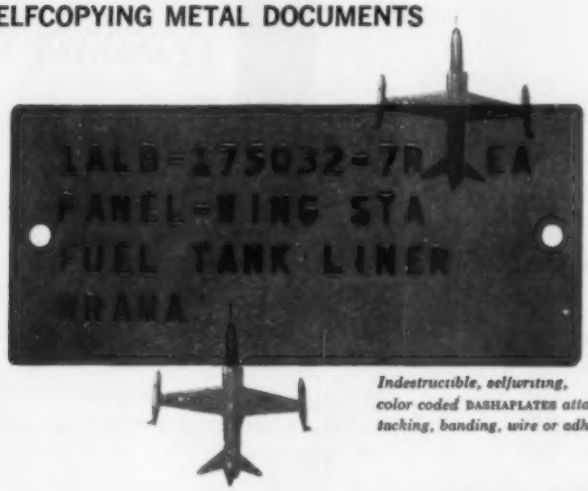
WITH DASHEW SELFCOPYING METAL DOCUMENTS



Indestructible, selfjuriting, color coded DASHAPLATES *attach by tacking, banding, wire or adhesive.*

The validity of management decisions resulting from electronically prepared reports is directly proportionate to the accuracy of the source data.

Since 1951 Air Force Managers have been replacing paper tagging, stencilling, and other perishable methods of identifying materiel with embossed Dashaplates . . . reducing errors in the logistical system due to lost identity and the manual copying of data to source documents.

RUGGED DASHAPLATES ELIMINATE LOST IDENTITY

Data embossed on lightweight, color-coded metal Dashaplates stands up against sandstorms, typhoons, tornadoes, chemicals, seed blast, heat, flame, rodents and vermin.

SELFCOPYING FEATURE ELIMINATES TRANSCRIBING ERRORS

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6000 Dashaplate identification tags per hour are processed by the Databosser which simultaneously attaches tying wires, embosses sequence numbers and performs other specialized functions. Databossers, controlled by punched cards or tapes, may be integrated into electronic data processing systems.

Military and industrial organizations throughout the world are saving money through the use of Dashew equipment and systems for identification and control in production, overhaul, shipping and storage.

Call us collect or write for information on how Dashew can expedite operations . . . save labor time . . . eliminate costly "lost" identification, and, provide a sound foundation for electronic data processing.

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DETECTION OF THE FREE NEUTRINO

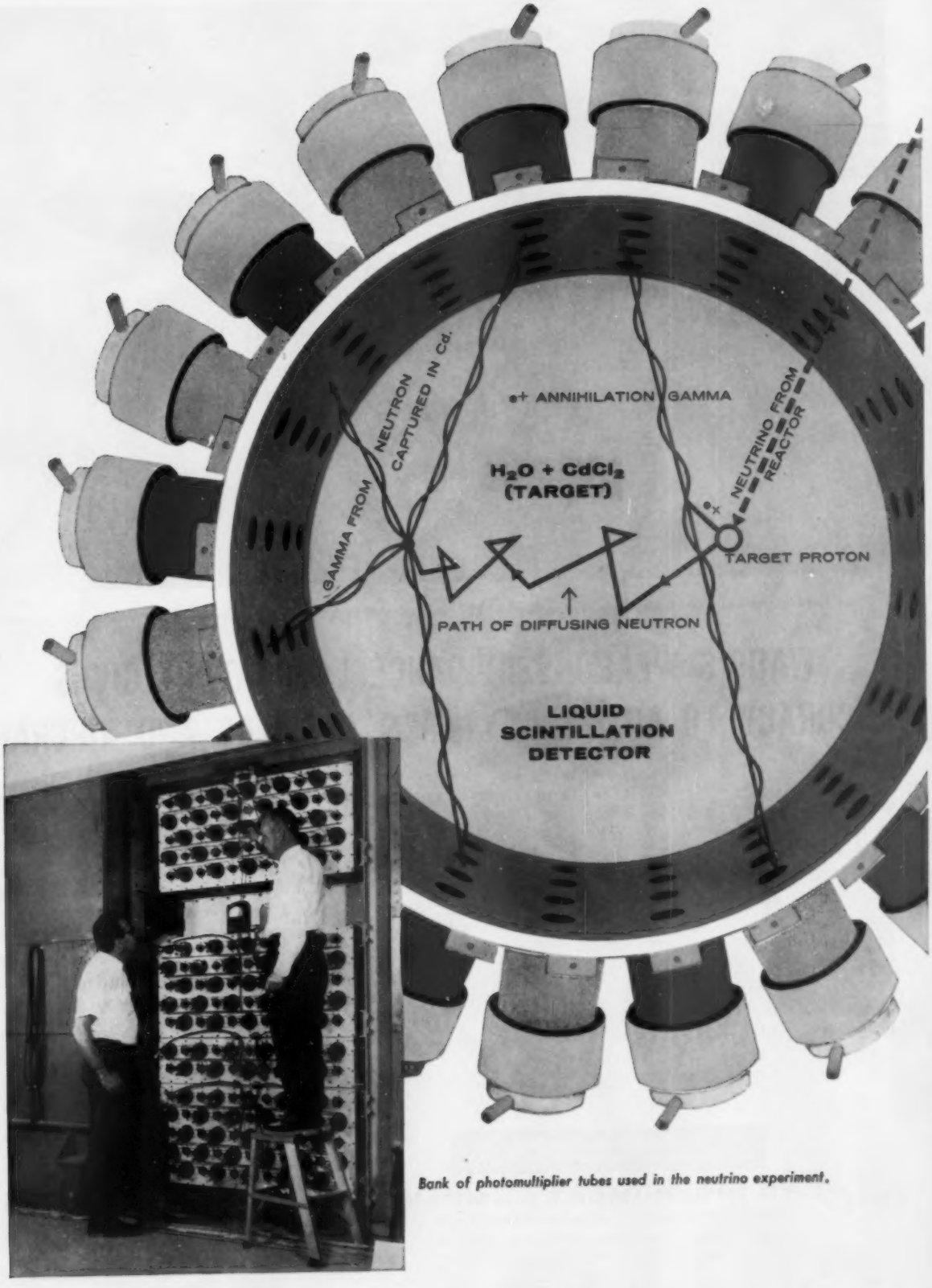
Working with the most modern technical equipment, a team of scientists of the Los Alamos Scientific Laboratory has recently demonstrated the existence of the free neutrino*. Such an experiment is the culmination of work on the frontiers of physics, chemistry and electronics, in which the very latest advances in nuclear theory, scintillator development, and electronics are combined to achieve an important milestone in scientific progress. Teamwork of this kind is typical at the Los Alamos Scientific Laboratory, which welcomes applications for employment from qualified scientists and engineers. For more information, write:

*C. L. Cowan, Jr., F. Reines, F. B. Harrison, H. W. Kruse, A. D. McGuire, *Science* 124, 103 (1956)

Director of Scientific Personnel
Division 1618

los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

Los Alamos Scientific Laboratory is operated by the University of California for the U. S. Atomic Energy Commission.



Bank of photomultiplier tubes used in the neutrino experiment.

U. S. Air Force Photo

Designed basically for night photographic work, the Martin RB-57 is employed by USAF TAC, powered by two Wright J-65 jet engines.

WADC'S WEAPONS GUIDANCE LABORATORY GIVES ACCURACY TO AIR FORCE BOMBS, MISSILES AND AIRCRAFT

The Weapons Guidance Laboratory at the Air Research and Development Command's Wright Air Development Center performs applied research and development of all Air Force weapons guidance equipment.

Included under this broad category are airborne bombing systems and equipment, weapon defense systems, offensive fire control systems, missile guidance equipment, electronic jamming systems, chaff systems, navigation systems, manual navigation aids and special test equipment peculiar to the requirements of the weapons guidance systems or equipment. In addition, all components of the foregoing are the province of this laboratory. The facilities available for these studies include various gun ranges, temperature and altitude chambers and other specialized test and evaluation installations.

Weapons Guidance is one of the laboratories that form the Wright Air Development Center. WADC, in turn, is the largest Center under the Air Research and Development Command. At its location at Wright-Patterson Air Force Base, Ohio, upward of 10,000 military and civilian workers are engaged in research, development and testing of aircraft, guided missiles and all types of associated flight and ground equipment.

This is one of a series of ads on the technical activities of the Department of Defense.

105

FORD INSTRUMENT COMPANY

DIVISION OF SPERRY RAND CORPORATION

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Engineer of Ford Instrument Company checking unit designed by the Company for the Air Force to be certain that its magnetic effects will not affect other instruments in the aircraft.

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Get Better Production Balance, Easier Automation, Faster Installation

New Danly presses stand up to full capacity operation, single shift or around-the-clock, with minimum down-time . . . you get the performance you plan on. No more "production pile-up" with presses producing at less than full capacity or shut down entirely. Controls are "built-in" for convenient floor level adjustment, ideal for automation, designed for maximum safety.

Each press is delivered pre-tested and ready to go . . . saving weeks of costly erection time.

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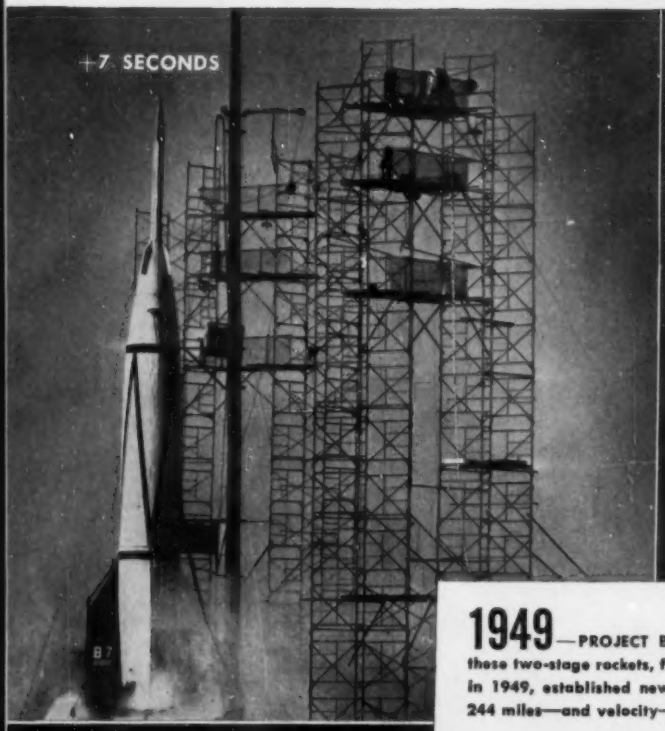
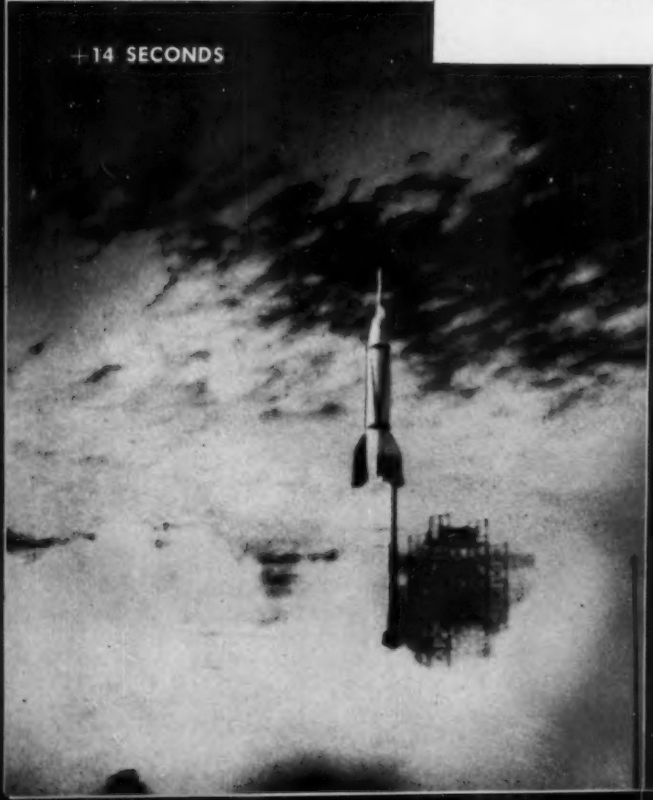
How General Electric Experience



1949—PROJECT BUMPER—The fifth of these two-stage rockets, fired by General Electric in 1949, established new records of altitude—244 miles—and velocity—5150 mph.



Advances Missile Technology

General Electric's Project Bumper established new records of altitude and velocity. But far more important is the valuable research data compiled in the successful completion of the Bumper project. Many problems were overcome with Bumper—problems in temperature, telemetry, separation, and aerodynamics. Bumper helped solve the problems of communicating with missiles at extreme altitudes, and was a major preliminary step in the development of a satellite. In solving these and other problems, General Electric has contributed a wealth of research data to the missile industry—information that is being utilized on the nation's top priority ballistic missile project.

General Electric's Missile & Ordnance Systems Department presently is working on an Air Force prime contract to develop the ICBM nose cone. Programs are being carried out in such varied fields as communications, hypersonics, metallurgy, mathematics, and thermodynamics to support this nose cone contact.

General Electric has formed the Missile & Ordnance Systems Department to act as a Company focal point for large, highly complex missile projects. Scientists in the new department, backed up by the vast resources of many General Electric operating departments and laboratories, are currently working to solve the perplexing problems associated with the ICBM nose cone and other missile projects.

By focusing this wide range of specialized talents of General Electric personnel on highly complex defense system problems, the Missile & Ordnance Systems Department is making significant contributions to America's defense program. Section 224-5, General Electric Co., Schenectady 5, New York.

ENGINEERS: G.E.'s Missile & Ordnance Systems Department is currently expanding its staff of highly skilled engineers and scientists. If you have a background of successful creative engineering, send your qualifications to: Mr. George Metcalf, General Manager, Missile & Ordnance Systems Department, General Electric Co., 3198 Chestnut St., Philadelphia, Pa.

TODAY—**CONTINUED RESEARCH AND EXPERIMENTATION in advanced missiles and missile systems is helping solve such advanced problems as development of the ICBM nose cone. Headquarters for General Electric's participation in these programs is the Missile & Ordnance Systems Department in Philadelphia, Pa.**

MR. ROBERT P. HAVILAND, Flight Test Engineer at MOSD, directed Project Bumper and other advanced programs, gaining valuable experience which he is currently applying to present missile programs.

DR. YUSUF A. YOLER—widely known for research in hypersonics—is currently engaged in the design and development of wind tunnels, shock tunnels, mass accelerators, and other facilities for continued progress in missile systems.

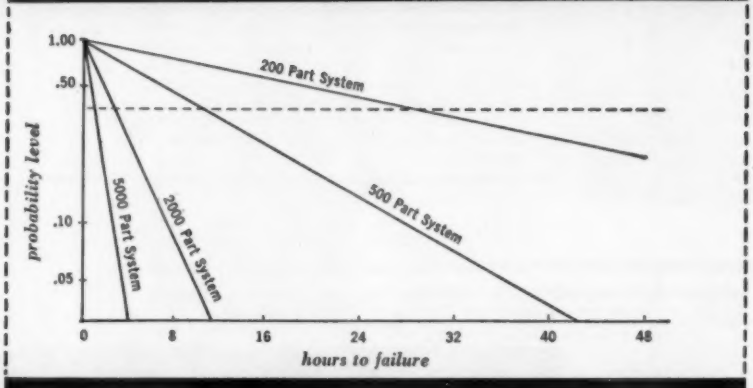
Progress Is Our Most Important Product

GENERAL ELECTRIC

AVION

advances the cause of

HIGH RELIABILITY
through
SIMPLIFIED DESIGN



Avion's "High Reliability" program is fundamentally a philosophy of plus performance . . . derived in large measure from a bold concept of design simplicity.

It's just that simple!

The fewer the number of components required for any electronic system—the longer the life expectancy of effective performance.

High Reliability has been achieved for missile guidance, fire control, infrared seeker, and other systems . . . largely through the application of this design concept. The relationship between simplicity of design and plus performance is firmly established at Avion.

And this relationship is sound, whether the electronic system is designed for the military, or for industrial use.

Investigate the career opportunities in our expanding organization.

AVION DIVISION

ACF INDUSTRIES INCORPORATED
11 Park Place, Paramus, N. J.

ATOMIC ENERGY

TEST REACTOR POLICY

The Atomic Energy Commission is looking to private industry for the construction and operation of general-purpose test reactors to meet growing needs of the Commission in its reactor-development program and those of private industry in the development and construction of nuclear power plants.

To encourage private enterprise to enter this phase of the atomic-energy industry the Commission will construct test reactors only if its needs for irradiation space cannot be met by private industry under contracts reserving for Government use a percentage of the space available in privately owned test reactors.

In addition, the Commission will permit the use of Commission-owned test reactors for non-Government purposes only if privately owned facilities are not available for the irradiation services required.

Reactors which come within this policy of the Commission include facilities in which materials and reactor components may be subjected to an environment (temperature, radiation intensity, exposure to corrosive materials, etc.) comparable to or identical with conditions which would obtain in reactors in which it is intended to use the materials and components. Also included are facilities used to study the effects of radiation on electronic and other components of military vehicles or weapons systems.

The Commission believes that a large part of its requirements for test reactor facilities can be met with privately owned reactors based on proved designs and technology.

Until private industry is ready to finance the design, development, construtions, and operation of test reactors of advanced design, the Commission's policy envisages a continuing Government rôle in this field and in the development of research reactors of new and improved design which are needed by the National Laboratories to carry forward research work assigned to the laboratories. Research reactors provide only limited amounts of space for testing purposes.

The new test reactor policy is another in a series of steps taken by the Commission to bring commercial suppliers into the atomic energy industry. Fuel elements for the Materials Testing Reactor at the National Reactor Testing Station in Idaho—reactor-grade zirconium, hafnium, and beryllium—are being procured

THE BUSINESS OF AMERICA'S DEFENSE . . .

IBM IN ACTION

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PEACE!

Heart of a new weapon system in America's inventory of counter-measures that guard the peace is an IBM airborne computer—specially designed and built to guide America's most powerful bombers with unbelievable precision and certainty.

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Heavy Duty

. . . with reinforced metal ends

The heavy wall is spirally wound, with multiple layers of high grade paperboard, closely butted and evenly bonded with adhesive to give extra strength and long use.

Moistureproof . . .

Immune to wear and tear . . .

Self-locking metal ends.

Excellent for shipping plated metal strips, shafts, rods, tubes and many other metal parts . . . also, used as cores for paper rolls and fabrics; bodies for reels; liners for metal drums. Available in diameters and lengths as desired.

Usable for storage or reshipment.

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THE CLEVELAND CONTAINER COMPANY

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CLEVELAND CONTAINER CANADA, LTD.

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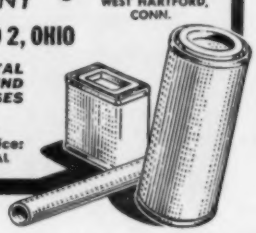

from commercial suppliers through long-term contracts.

POWER REACTOR STUDY

A design study and development work to determine the feasibility and economics of heavy-water-moderated reactors for electric power generation will be undertaken for the Atomic Energy Commission by E. I. du Pont de Nemours & Company. The study will pay particular attention to the utilization of natural uranium as fuel.

The work will be performed under the existing contract between the Du Pont Company and the Commission for the operation of the AEC's Savannah River Plant in South Carolina. Du Pont will utilize personnel from both the Savannah River Plant and its main office in Wilmington, Del., in carrying out the study. Laboratory and research facilities at Savannah River will be used in connection with the program.

The study represents a further broadening of the scope of development work currently being undertaken by the Commission in its power reactor development program. The Commission asked the Du Pont Company to undertake the study because of the company's experience in the development, design, and operation of the Savannah River production reactors in which heavy water is used as the moderator and primary coolant. The agreement makes no commitment for construction of a power reactor.

PRICES GUARANTEED

The Atomic Energy Commission has established guaranteed fair prices to be paid for plutonium and uranium-233 produced in atomic reactors operated under license in the United States and delivered to the Commission for the one-year period beginning July 1, 1962.

The prices are: for plutonium metal, $12 a gram; for uranium-233 nitrate, $15 per gram of U-233. These prices are based on the estimated fuel value of the materials and are identical with those to be paid for these products of reactors abroad fueled with material supplied by the United States.

Previously the Commission had established classified guaranteed fair prices for these materials produced in atomic reactors operated under license in the United States for the 7-year period beginning July 1, 1955 and ending June 30, 1962, and those prices remain in effect for that period.

The Commission announced that it intends to continue the practice of extending annually, for one year, the period for which guaranteed prices have been established so that the guaranty period will extend at least six years in advance at any one time.

STEAM CATAPULTS FOR NAVY CARRIERS are made at Bliss' Canton plant. Shaft shown here is ground to special taper by mounting grinder on lathe post and guiding it with a specially built duplicating device.

20-mm MACHINE GUNS. Here, barrels are given a salt bath heat treatment in Bliss plant. In addition to production of 20-mm machine guns Bliss manufactures cartridge case and shell making machinery and other ordnance equipment.

NUCLEAR REACTOR CONTROL RODS produced for the AEC by Bliss. Production requirements involve unusually precise machining and welding practices.

Virtually no contract machining or fabrication job is too large for Bliss facilities. And Bliss' record of long experience and successful performance on past contracts, both civilian and military, is your assurance of precision craftsmanship. In short, before you decide who's going to build it, it's wise to get a bid from Bliss.

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General Offices: Canton, Ohio
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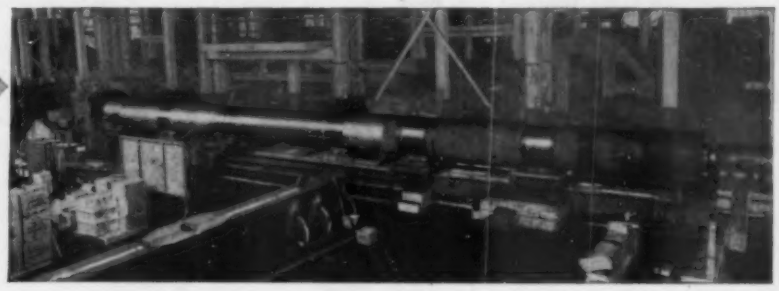
Add these facilities to your own: 11 plants • 2,000,000 sq. ft. • An estimated $44,000,000 inventory of modern tools • Two Meehanite foundries, one iron and one steel foundry • Two fully equipped welding departments.

140-TON FORGINGS. The 70-foot tie rods for the great hydraulic presses built under the Air Force Heavy Press Program filled little more than half the 120-foot bed of this huge engine lathe. It is one of the more-than-100 lathes in Bliss' 675,000 sq. ft. Canton, Ohio, plant.



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Atomic Energy (Contd.)

ATOMIC MERCHANT SHIP

The Atomic Energy Commission has accepted as a basis for contract negotiations a proposal by the Babcock & Wilcox Company of New York to design, construct, and test-operate a nuclear propulsion plant for a nuclear-powered merchant ship. The award of a contract will depend on the successful completion of the authorized negotiations. The ship itself will be built under contract to the Maritime Administration.

Under the proposed contract, Babcock & Wilcox will design, construct, and test-operate a 20,000-shaft-horsepower pressurized-water reactor system of advanced design. The project is to be completed in thirty-nine months.

The pressurized-water reactor system was chosen to power the merchant ship because a large background of fundamental information has been accumulated in experience to date on this type in various atomic-energy programs. Consequently it offers the best prospect for achieving desired technological advances in a relatively short time. Selection of this concept of demonstrated operability will also assure that there will be early opportunity to study the practical aspects of operating atomic merchant ships.

The reactor for this first nuclear-powered ship will be unclassified, and the new technology developed in this project will be available to American industry. It also will afford an opportunity to engineers and scientists of other nations to understand nuclear-powered ships.

ATOMIC FUEL FOR JAPAN

A lease agreement between Japan and the United States to provide fuel containing two kilograms of uranium-235 (20 per cent U-235 enrichment) for a research reactor was signed recently. The lease agreement is the first transaction in special nuclear materials under the new program for foreign assistance announced November 18, 1956, by President Eisenhower. The agreement was signed by Ambassador Masayuki Tani for Japan and by Acting AEC Chairman Harold S. Vance for the United States.

The fuel is for a 50-kilowatt water-boiler type of reactor to be installed at the new nuclear research center being constructed seventy-five miles northeast of Tokyo for the Japan Atomic Energy Research Institute. The reactor is being built at Canoga Park, Calif., by Atomics International, a division of North American Aviation, Inc.

The lease agreement with Japan provides for the first transfer of fissionable material to another country under the Agreements for Coöperation Program since the execution in August 1955 of a lease with Switzerland for fuel for that nation's research reactor.

AMERICAN ORDNANCE ASSOCIATION

Founded 1919

A patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense

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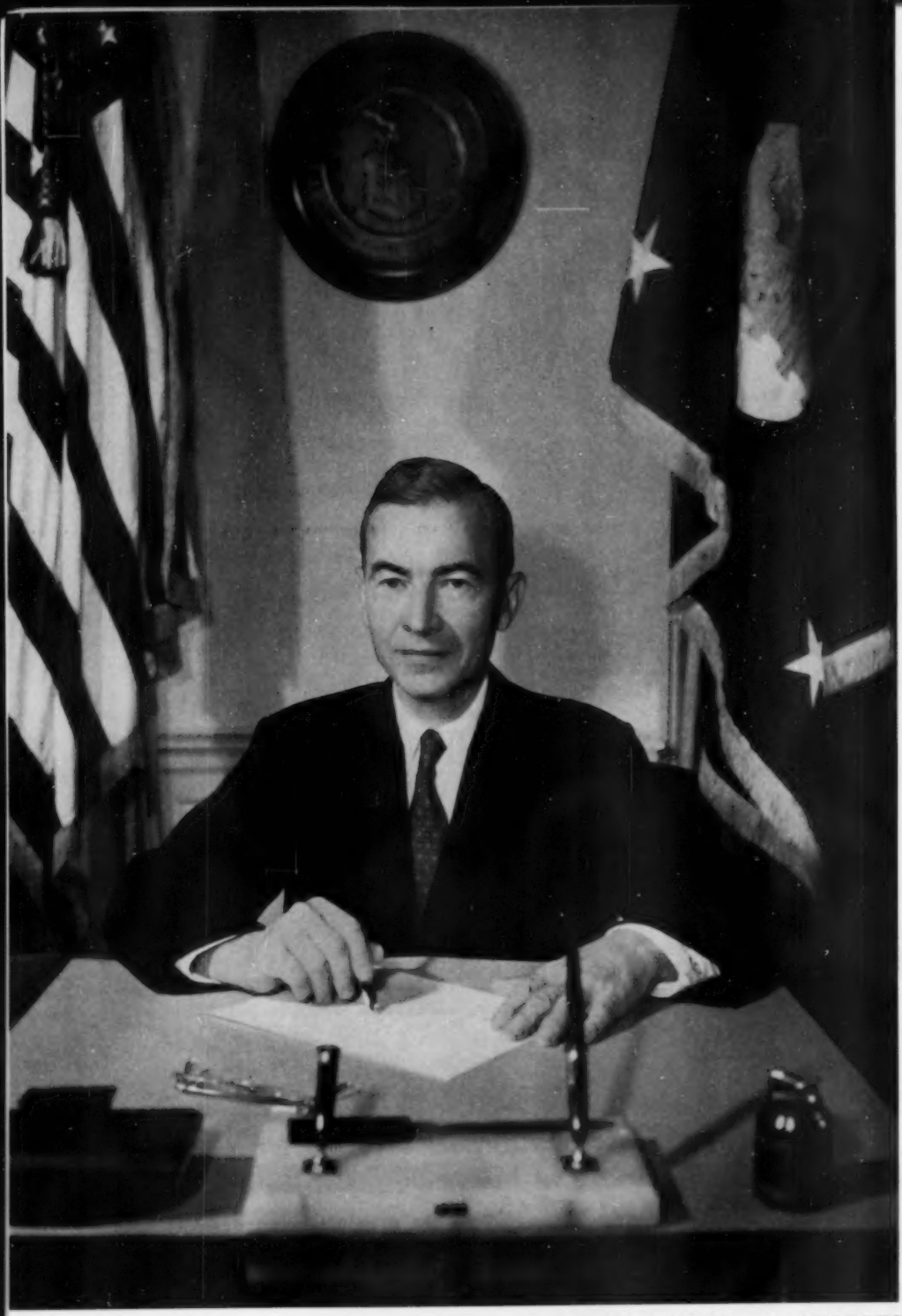


HON. DONALD A. QUARLES

Secretary of the Air Force

Air Force Leadership

Secretary Quarles gives strong direction to a vital defense program

THE Air Force Establishment with its strategic, tactical, and continental-defense missions, its vast array of heavily armed aircraft and weapons systems that are made possible by an enormous air material and research organization, is the biggest business in the Department of Defense—in turn the largest enterprise in the United States.

The growth of the Air Force in its brief ten years of independent existence has been keeping pace with the equally phenomenal increases in firepower and speed made possible by nuclear energy and jet propulsion. Today's air weapons systems operate at such speeds that control by men must give way to automatic electronic control.

The research, development, testing, production, and operation of the vast amounts of equipment involved in this ten-year growth have required the devoted attention of thousands of men both in the military and in industry.

In the examination of such amazing progress one looks for the men who must supply the brains and the drive to achieve it. Such achievement necessarily has required the devoted, experienced, and skilled attention of many military leaders. They have been men who in themselves represent a combination of combat and technical knowledge. However, that is never sufficient for an enterprise on a national scale.

IT requires leaders at an even higher level who must be skilled also in welding the national interests with the facts of life regarding industry, government, and manpower. Here the citizens of the United States are fortunate in the selection of one of the most able and experienced men—with the administrative and technical knowledge and the common sense needed to direct all the complex aspects of air power—Secretary of the Air Force Donald A. Quarles.

Hon. Donald A. Quarles, the Secretary of the Air Force, was born in Van Buren, Ark., in 1894 and was graduated from Yale University in 1916. After serving with the American Expeditionary Forces overseas for two years he was discharged in 1919 with the rank of captain in the field artillery.

That same year he became associated with the Western Electric Company, later serving in the Bell Telephone Laboratories in various capacities. In the earlier part of this period he studied theoretical physics at Columbia University.

From 1929 to 1940 Mr. Quarles was in charge of the outside plant development department of Bell Telephone Laboratories and from 1940 to 1944 was director of the transmission department whose work on coaxial transmissions greatly advanced the effectiveness of voice communications and radar.

From 1944 until he became a vice-president in 1948, Mr. Quarles was director of apparatus development. In March 1952 he was appointed president of Sandia Corporation, a Western Electric subsidiary which operates the Sandia Laboratory in Albuquerque for the Atomic Energy Commission.

He was sworn in as Assistant Secretary of Defense in September 1953 and became Secretary of the Air Force on August 15, 1955. While in the Department of Defense he was chairman of the Air Navigation Development Board and the National Advisory Committee for Aëronautics.

Mr. Quarles, from his earliest years, showed his great ability as that most unusual type defined by the great scientist Vannevar Bush as a "scientific statesman." During his long career with Western Electric Company and the Bell Telephone Laboratories he was in positions which demanded keen understanding of administration and personnel problems while at the same time directing research and experimental work that would lead to useful items easily produced.

The evidence of his ability can be seen in all directions in the constantly improving communication services that this country now enjoys.

Further evidence of Mr. Quarles' ability was his assignment as president of Sandia Corporation, the subsidiary of Western Electric Company which is involved in the nuclear-weapons program of the Atomic Energy Commission.

One of his first public appearances on the defense scene was at Detroit when, on June 9, 1948, he presented a paper on armament electronics at a technical seminar at the Association's Thirtieth Annual Industrial Preparedness Meeting.

WHEN a wise man was needed to tie together the thousands of loose ends and duplications among the research activities in the Military Establishment, Mr. Quarles was called in by the Government and appointed Assistant Secretary of Defense for Research and Development.

It gives us a feeling of great confidence to see that in its Secretary of the Air Force the country now has a devoted citizen of proven ability who always has acted to ensure that the United States Air Force has no superior in the world.

In each assignment and in every office he has served with great distinction. Over the years Secretary Quarles has been a loyal friend as well as a member of the American Ordnance Association, and the membership of the A.O.A. pledges him its continued support.

The Vanguard Satellite

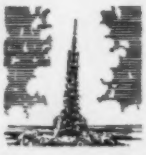
Establishment of such a vehicle in an orbit around the earth will make possible great advancements in our knowledge of the upper atmosphere, possibly resulting in undreamed-of future scientific developments

Dr. Clifford C. Furnas

MAN has never been really content with his feet of clay and his earth-bound existence. The first successful attempt to rise above the condition that nature had apparently placed him in came in Paris on November 21, 1783, when M. De Rozier and Marquis d'Arlandes carried out the first man-carrying flight in a Montgolfier hydrogen-filled balloon.

The second important step in rising beyond the bounds of the earth's surface came on December 17, 1903, when Orville Wright flew the first successful heavier-than-air flying machine.

The beginnings of the third phase of success (if everything goes according to plan) will come sometime during the latter part of 1957 or 1958 when an attempt will be made to launch the first man-made scientific satellite and maintain it on an orbit a few hundred miles above the surface of the earth.



The impetus and the motivation for this preliminary attempt at space travel came from the program of the International Geophysical Year. This International Geophysical Year (IGY) is a series of scientific experiments and observations in the various earth sciences, involving the concentrated efforts of some forty-five nations of the world during the period from July 1, 1957, to the end of 1958.

The program was set up in 1954 under the general jurisdiction of a Comité Special Pour L'Année Geophysique Internationale (CSAGI) and covers almost all facets of the earth sciences and all parts of the globe from pole to pole and through the equatorial regions.

Dr. Furnas is the Assistant Secretary of Defense for Research and Development. He is currently on leave from his post as chancellor of the University of Buffalo, Buffalo, N. Y., until February 1957.

During the initial planning it appeared to many of the international scientists that something was lacking and that the time was now ripe for advancing our knowledge of that region of the earth which extends beyond what we normally call the atmosphere. Hence, the International Committee (CSAGI) in 1954 adopted the following resolution:

"In view of the great importance of observations over extended periods of time of extra-terrestrial radiations and geophysical phenomena in the upper atmosphere, and in view of the advanced state of present rocket techniques, it is recommended that thought be given to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments, such as power supply, telemetering, and orientation . . ."

This resolution of the CSAGI was a noble resolve for a noble experiment, but there is a great gap between dreams and reality. Although many scientists and engineers recognized that the art of rocketry had advanced *almost* to the state where the launching of a satellite might be possible, it was obvious that the knowledge and resources required for physical realization of the launching resided only in certain national military establishments.

THIS posed several problems, since it was essential that the scientific program be international in character and free of any element of secrecy. The United States, however, considered the problem from all angles and in the summer of 1955 accepted the challenge. The Department of Defense set up a program to contribute in a substantial way to this satellite program.

I wish to emphasize that simply getting the satellite on an orbit is not the end objective, and the Department of Defense does not—and will not—dominate the program and will in no way interfere with the international, geophysical, and scientific objectives. A few details of the launching equipment and program must, for military reasons, remain classified. Aside from these, however, the entire program is unclassified, and full information is or will be made available to the international scientific community.

The over-all United States respon-

sibility for the program rests with the National Academy of Sciences and the National Science Foundation. For planning and coördinating this very important project the United States National Committee for the Geophysical Year set up a technical panel on the Earth Satellite Program within the National Academy of Sciences.

THE over-all project for launching the satellite is known as Project Vanguard, and the responsibility for carrying it out—with the aid of some thirty-five contractors and subcontractors—rests with the Office of Naval Research.

Since the propelling of a satellite into its orbit will carry the body out beyond the sensible atmosphere, it is obviously a task for rockets, which carry their own oxidant as well as their own fuel. Rocketry has a long history. It began in the fourteenth century in a very crude form shortly after the Chinese had invented gunpowder and was carried on in about the same manner of excellence through various simple implements of war and pyrotechnic devices for celebrations.

The first truly scientific contribution came in 1919 from an American, Dr. R. H. Goddard of Clark University, when he published an article entitled, "A Method of Reaching Extreme Altitude." This dealt with theoretical and scientific work in the first liquid-fueled rocket.

The outstanding practical application of rocketry came during World War II in the form of the German V-2 which was, to a very large extent, the result of the skillful work of Dr. Wernher von Braun and Dr. Walter Dornberger.

ONE has only to read the current popular and scientific press to know of the tremendous amount of work and advancement that has been made in rocketry in the United States in recent years. A satellite program could not be considered seriously until this basic means of propulsion had been carried to a high state of development.

The United States IGY satellite program, as it now stands, encompasses the use of six preliminary rocket systems for test purposes to be followed by six complete rocket-guidance and control systems which will have as their objective the launching of at least one satellite on orbit at least 200 miles above the surface of the earth. The launchings of the instrumented satellites are now scheduled to begin during the last quarter of the year 1957.

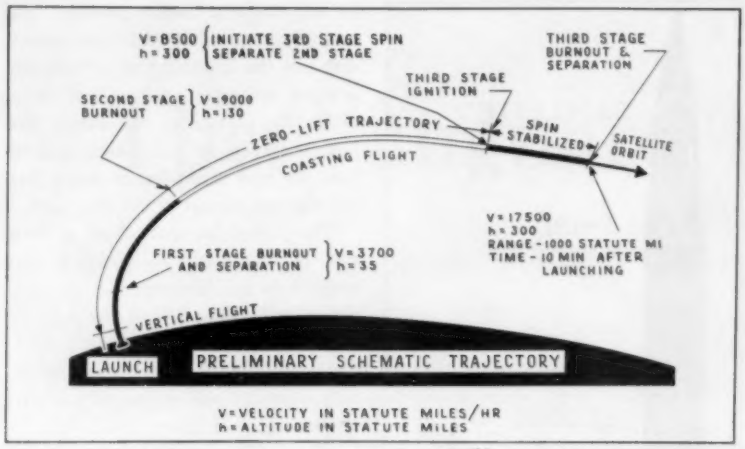
The probability that all six of these will be completely successful is very small. I do feel, however, that the probability of getting at least one into the orbital position is quite good. Only time and the efforts of many of our best scientists and engineers will give us the final box score.

The satellite itself will be a 20-20 affair, a sphere about 20 inches in diameter and weighing about 20 pounds. Actually the present design weight of the satellite is 21½ pounds. The whole assembly, the complete Vanguard vehicle made up of the satellite and its three stages of rockets, will be about 70 feet long and 45 inches in diameter and will weigh about 22,000 pounds. The first stage will weigh approximately 17,800 pounds and will be propelled by a liquid rocket motor using liquid oxygen as the oxidizer and jet kerosene as fuel. This power plant will develop a thrust of about 27,000 pounds.

AT take-off the Vanguard will first rise vertically. The launching rocket will then follow a programmed tilt in the direction of a chosen trajectory. One hundred and forty seconds will have elapsed by the first-stage burnout. The rocket will then be some 35 miles high and moving at about 45 degrees to the horizontal with a velocity of 5,600 feet a second.

The first stage will then be discarded and the second stage will enter the picture. This will also be a liquid-propellant rocket. The oxidizer will be nitric acid, the fuel, unsymmetrical dimethylhydrazine. This second stage also will burn for about 140 seconds and, carrying in itself the third stage which bears the satellite toward the orbital altitude, will weigh approximately 4,770 pounds. Its burnout velocity, including the earth's rotational velocity, will be nearly 14,800 feet a second.

All during the burning of this second stage the rocket will continue to



The three progressive stages of the satellite enroute to its orbit.

tilt more and more toward the horizontal. At the end of the burning, the second-stage combination will be about 140 miles high and will coast to a peak altitude of about 300 miles at roughly 700 miles from the launching point. The velocity at that point will be about 13,070 feet a second.

The inertial-guidance equipment, entirely in the second stage, will automatically orient the rocket with the proper attitude after burnout. When this orientation of the second and third stages has been completed, the third-stage rocket, consisting of a single solid-propellant cylindrical motor, will be spun about its longitudinal axis up to about 100 to 200 revolutions a minute, for gyroscopic stability.

AFTER the third-stage rocket is spinning and the peak of the trajectory has been reached, the second and third stages will be separated and the final stage will be fired. The final stage will impart roughly fifty per cent of the required velocity to the satellite itself. A short time after the end of the third-stage burnout, small retroactive rockets will cause the satellite itself and the third-stage rocket case to separate from each other, by a few feet a second.

The velocity at this point is calculated to be about 26,470 feet a second. The satellite, if everything has gone well, then will be on its course and will maintain itself there without further propulsive effort. It will be ready to be observed or interrogated for scientific information. If that velocity is achieved, the satellite will probably swing in an elliptical orbit with a 300-mile perigee (closest approach to the earth) and a 1,500 mile apogee (farthest distance from the earth).

At this speed, and with this elliptical orbit, the satellite will circumnavigate the earth about every 90 minutes and it will stay in that orbit until the resistance of the minute quantities of gases, or of any ambient solid particles in space, slows it down below the critical velocity of about 25,000 feet a second. Then it will descend rapidly into the atmosphere of the earth and disintegrate harmlessly, ending that particular experiment.

If the conditions of the upper atmosphere are as estimated by some scientists, the satellite may exist as long as a year. Moderate performance would be as much as a few weeks. The life depends largely upon the density of matter out beyond the sensible atmosphere. That extra-atmospheric density of matter is one of the things we are very curious about. The satellite will give us some answers.

THE launchings will take place at the Air Force Missile Test Station at Cape Canaveral in Florida. It is planned that the orbital path will be inclined about thirty-five degrees with respect to the equator. Hence, as the satellite progresses into multiple revolutions, owing to the regression of the nodes and the earth's rotation, it will pass over all observation stations within an equatorial belt some seventy degrees wide. This represents a band of over 4,500 miles in width and should give many opportunities for observations and measurements in both the Northern and Southern Hemispheres.

Two classes of both scientific observation and tracking will be possible: first, optical observation of the satellite itself from ground stations and, secondly, the reception of transmitted radio signals from the vehicle. A small transmitter and a small battery-power supply will be carried on board—enough to give out significant signals over a period of a few weeks, at least.

An important part of the measurements will be the determination of satellite position with respect to time at different parts of the earth. Depending upon the reflectivity, the satellite will have a brightness of the order of a fifth- or sixth-magnitude star and, if the location is known rather exactly for a particular time under very clear atmospheric conditions, it might be observable with a good pair of binoculars.

IT should be very readily observable with a modest astronomical telescope, if one knows approximately where to look for it.

Twelve prime astronomical observatory stations are being planned in different parts of the world, with some 200 secondary stations. Thirty-five of these secondary stations are presently organized, and it is hoped that many other nations and amateur groups may enter into this program of physical observation. The best periods for optical observation will be about an hour after sunset and about an hour before sunrise.

The second means of determining position will be by transmitted radio signals from the satellite itself. These will be received by a "Minitrack" station (a system developed by the Naval Research Laboratory) which, by phase-comparison, will be able to determine position with a very high degree of accuracy. The Minitrack stations also are capable of receiving stored and coded telemetered scientific data from the satellite.

Though all details have not yet been determined, some parts of the measurement program are reasonably fixed. The

minimum temperatures on and within the satellite will probably be measured. By monitoring the interior pressure it may be possible to determine whether or not the shell is punctured by a meteor. There is also the possibility that the surface may be eroded, even though it is not punctured, by impact with very fine dust particles. It is possible to measure this.

COUNTERS can be used to measure the light from the sun in that region well above the atmosphere in both ultraviolet and X-ray wave lengths. The spectral distribution of the radiation coming not only from the sun but from outer space can also be measured and evaluated.

A magnetometer in the satellite can provide a time record of the earth's magnetic field above the ionosphere. With Geiger counters and other devices it should be possible to study the low-energy cosmic rays which do not penetrate the earth's atmosphere. These are some, but by no means all of the possibilities.

In the minds of many the question will immediately arise, what practical thing will come from all these scientific observations? That is the sort of question that cannot be answered out of hand any more than one can predict what might be found on a new continent before it is discovered. Be it noted, however, that in nearly all cases additions to the fund of human knowledge have led to many practical applications. I am sure that this will be true also in the case of the Vanguard satellite.

For instance, by these experiments we will accurately determine the density of the varied diffuse materials out and beyond the sensible atmosphere. This knowledge will be very important if we expect to go into very high altitude travel above the surface of the earth.

MANY of the observations undoubtedly will be on phenomena that have influence on the character of the weather near the surface of the earth. We will be better able to predict, not only on the short- but also on the long-range basis, phenomena in the atmosphere which lead to our weather pattern.

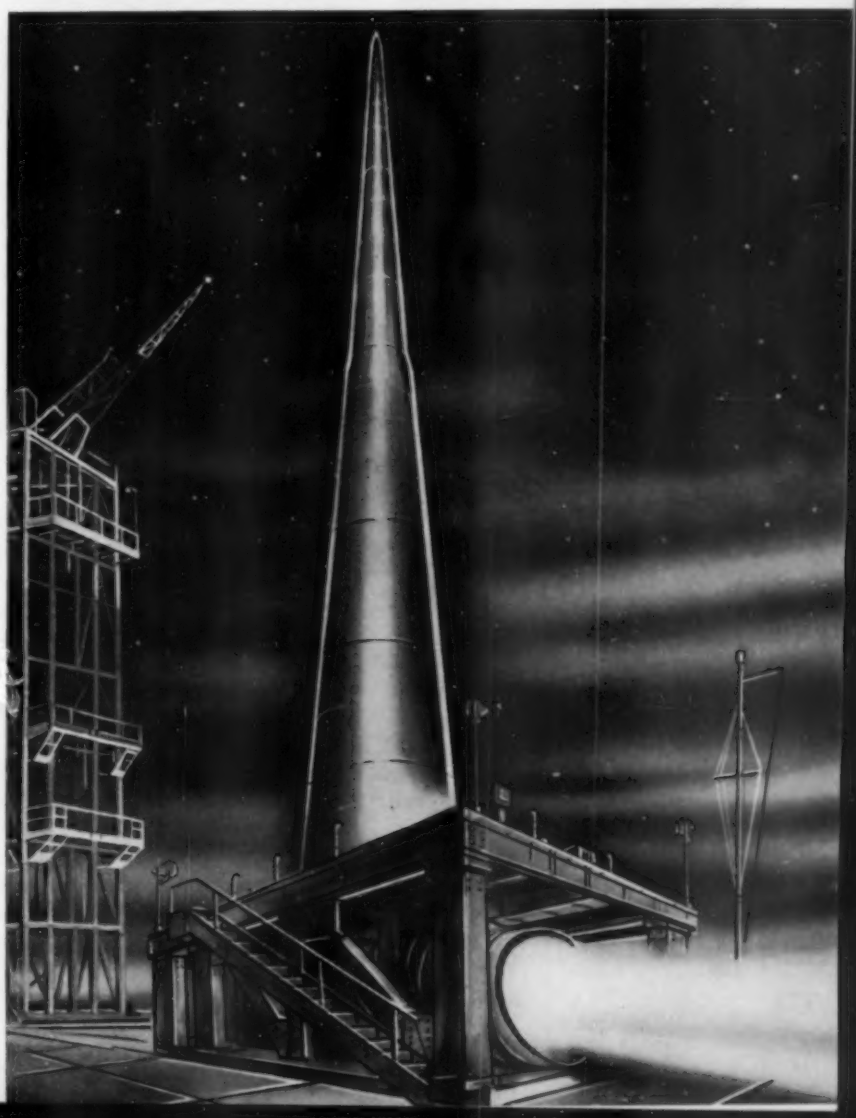
As we learn more about the electrical and mechanical phenomena of the upper atmosphere, we will be able to improve our communications greatly. As more observations are made on the spectral and energy distribution of the radiation from the sun and other parts of the universe, we are going to learn more about the nuclear reactions and the energy exchanges that take place in the stars.

This could mean the eventual production of a practically endless supply of controlled energy for the human race for all times to come. These are rather amateurish speculations on some of the practical benefits which may be forthcoming. Experts can certainly generate many more.

To those who are enthusiastic about space travel and are impatient to get on their way, the satellite may appear to be a very feeble experiment. It will not travel out beyond the gravitational bounds of the earth and will only weigh 21½ pounds. Be it noted, however, that the velocity of the satellite on orbit will be about five-sevenths of the escape velocity which will be necessary for true space travel. As far as velocity is concerned, we will be over seventy per cent along our journey toward the ultimate goal with the first experiment.

AS far as size is concerned, this is merely a matter of scaling up the equipment which usually can be done if some one wants to undertake the expense and effort. We may never be able to outdo Buck Rogers, but if this first satellite experiment is successful, I would say that we are not doing badly.

Artist's conception of launching of earth satellite. Vapor blast at right is rocket exhaust. In left background is gantry crane used to emplace rocket.



Our Modern Army

It must continue to be equipped with a well-balanced variety of weapons, each fully adapted to a particular function and each the best of its kind that can be provided through the Science-Industry-Ordnance Team

Hon. Wilber M. Brucker

The Secretary of the Army

These remarks were delivered by Secretary Brucker at the Thirty-eighth Annual Meeting of the American Ordnance Association held at the Aberdeen Proving Ground, Md., on October 4, 1956.

SINCE it was founded in 1919, the American Ordnance Association has played a rôle of outstanding importance in fostering and strengthening the close partnership between American industry and our armed forces which is so vital to our national security.

Through its eighty Technical Committees the Association has successfully brought the know-how of many hundreds of individual industrial experts to bear upon some of the most difficult problems of ordnance design and production which have confronted the military services. The Army acknowledges an enormous debt to the American Ordnance Association.

Near miracles have been performed in many instances. I have in mind as one typical example the manner in which your Association aided in expediting the production of 3.5-inch bazooka rockets in the early days of the Korean war. Our hard-pressed troops sorely needed these tank-killers to stem the advance of the Russian-made North Korean armor, against which the bazookas of World War II were ineffective.

A few dozen test rounds of the 3.5 rocket at Aberdeen were all we had. There were only a handful of launchers in existence. It seemed almost too much to hope that launchers and rockets could be gotten into mass production and shipped to Korea in time to help turn the tide.

Yet it was done. The groundwork had been laid. Your members had studied the bazooka designs and had painstakingly worked out with Army Ordnance adaptations which made possible production by machine tools which were widely available. It had been determined which private concerns could most promptly manufacture the various component parts.

As a result, only twenty-five days after the Communist troops poured out of North Korea, thousands of launchers and tens of thousands of rockets had been manufactured and flown 6,000 miles across the Pacific and were knocking out Communist tanks!

This instance does not stand alone. It merely illustrates the pattern of teamwork which has paid tremendous dividends in terms of the combat capability of our troops and the safety of our Nation. Today, as we seek to build and maintain the military strength necessary to prevent war and ensure the security of the United States against the ominous armed might of the Communist conspiracy, this military-industry teamwork is of even more vital importance than ever before.

WE are engaged in a challenging technological race with the Soviet Union, which is placing unlimited emphasis upon the development of its total scientific and industrial potential in order to outstrip the free world, if possible, and obtain military supremacy. For our part, we must leave nothing undone to develop the phenomenal technological advances of recent years for our own protection.

We simply cannot afford to take the least chance of coming out second best to any nation in the development of new weapons, new equipment, and new methods. We must stay ahead so as to keep our deterrent power to prevent war—but if it should come, to win any war that might be thrust upon us. The rôle of the American Ordnance Association is vital and significant. You are performing an invaluable service for America.

Our magnificent Defense Team—Army, Navy, and Air Force—is a balanced, tridimensional ground, sea, and air team so constituted that it is able to deal with any eventuality. Our streamlined Army of 1,025,000 is a most potent element of the team. It bears a

large share of responsibility for the success of the team as a whole. It must be fully capable of fighting to final victory in an all-out general war. It must be equally capable of dealing promptly with any other type of war, including any form of military aggression.

The Army is organized, trained, and equipped to carry out its indispensable mission under any circumstances. Its intrepid paratroopers, fast-moving infantry, hard-hitting armor, and far-reaching artillery, solidly supported by all the other branches of the service, give it incomparable combat capability and versatility. Its arsenal of conventional and atomic weapons provides unprecedented firepower.

The Army has the means to apply the exact amount of force required in any situation from the silent thrust of a bayonet to the tremendous blast of a guided missile. It is a mobile Army. Major units could be lifted by air across continents and oceans if necessary in time to deal effectively with aggression and promptly reënforce our garrisons in all parts of the world.

IT will have the tactical mobility to cope with the conditions of an atomic battlefield—a vast area of military operations, rather than a battle line—requiring that troops be widely dispersed in relatively small combat groups to minimize the effects of nuclear weapons in the hands of the enemy, yet capable of swift movement to the attack in order to exploit the effects of our own tremendous firepower.

The fundamental importance of firepower and mobility as the twin keys to victory is emphasized in modern concept by the new 101st Airborne Division, which recently was reactivated as a combat division at Fort Campbell, Ky. The 101st Airborne embodies the most up-to-date thought in its organization, weapons, equipment, and in its employment of advanced tactical doctrine. The 101st with 11,500 men is organized into 5 combat groups, each a self-contained force. It will be completely air-transportable.

Because of the new types of lightweight weapons and equipment with which it will be provided, it will require only half the troop-carrier aircraft necessary to lift one of the previous types of airborne divisions. In addition to its conventional weapons—including a 90-mm. gun which can be dropped by parachute—it will have an Honest John atomic rocket unit as part of its organic artillery. It will also have an airborne television system to serve as the commander's eyes in searching out distant targets and a large number of light aircraft and helicopters for observation, command, and movement within a battle area.

The great display of modern weapons assembled at Aberdeen is a splendid reminder of the success that so far has been attained in equipping the Army with the best possible tools for the accomplishment of its mission—the best that our American scientific genius can devise and our industrial ingenuity can produce. Nevertheless it is in reality only a "progress report." We must think of what already has been achieved merely as a milestone and not a final goal.

It is essential also to remember that "best" does not connote a single weapon or family of weapons exclusively capable of serving all purposes. There is no such thing. The Army's arsenal must continue to be stocked with a well-balanced variety of weapons, each fully adapted to a particular function and each the best of its kind that modern technology can provide.

We have atomic weapons precisely tailored to the Army's needs which can be used with discrimination against close-in as well as far-distant targets with complete accuracy day or night despite rain, snow, fog, or any other weather condition. The Corporal guided missile, the 280-mm. gun, and the Honest John rocket give us a valuable interim atomic capability. In the not-too-distant future we will have whole families of guided and ballistic missiles and rockets to give artillery the vastly increased range and effect necessitated by the conditions of atomic warfare.

UNITS are being organized and trained to utilize one of these new missiles, the comparatively long range, extremely accurate and powerful Redstone missile. The Army is making good use of its thirteen years of pioneering experience in the missile field in developing missiles of far longer range.

It would be a grievous error for any one to think that, because it now has atomic weapons and guided missiles, the Army can discard all of its conventional weapons and rely on atomic firepower alone . . .

We can never afford to turn our backs upon any weapon until we have something definitely better in every important respect which performs the same function. In any situation that might develop, the Army must always have the means to apply the exact amount of force required to do the job at hand.

THE Army is not bound by tradition —it is simply awake to realities. While we are reaching out to explore fully every possible avenue of approach to the better weapon or piece of equipment in every category, and to examine every idea, we are at the same time determined to keep our feet firmly on the ground of practicality.

I have the greatest confidence that the teamwork of the Army and our sister services on the Defense Team, American science, and American industry—as exemplified so well in the American Ordnance Association—will continue to keep us safely ahead of any possible enemy in the technological race. I know that every challenge of the future will be met with the same ringing answer which has always been made in the past—nothing is impossible for the American Team!

"We must leave nothing undone to develop the phenomenal technological advances of recent years for our own protection. We simply cannot afford to take the least chance of coming out second best to any nation in the development of new weapons, new equipment, and new methods. We must stay ahead so as to keep our deterrent power to prevent war—but if it should come, to win any war that might be thrust upon us."

Which Weapons Tomorrow?

Today's research and development must continuously plan and evaluate offensive and defensive equipment for employment in any of a number of different kinds of war that may be forced upon us in the future

Mark S. Watson

Mr. Watson is a well-known military analyst and a member of the staff of the Baltimore Sun. *He is holder of the 1945 Pulitzer Prize for international correspondence and a frequent contributor to* ORDNANCE *magazine.*

AT the Aberdeen Proving Ground's triennial showing of ordnance advances last October, before members of the American Ordnance Association, there was an impressive demonstration not only of weapons but of an eternal problem of the Army; namely, what kind of war to prepare for?

The eternal problem has an eternal answer: Every kind of war. And that answer is not only expensive; it is difficult to explain to an unprofessional critic who demands why there has not been concentration on the exact type of war which ultimately comes around the bend.

The big demonstration at Aberdeen presented to view (besides the great guided missile Redstone, which is in a class of its own as a new device) a number of admirable new weapons, small, light, and air-transportable. To a degree they answer the prayers of the New Army advocates seeking weapons and equipment readily moved by airplanes (if airplanes are available in quantity, which happens to be in doubt). Also on display were several decidedly heavy types of tanks, guns, and trucks, which nobody can pretend are air-transportable.

The fact that all the devices in the two widely contrasting categories are good does not alter the fact that they are for two or more types of war. And should a war of Type A suddenly confront us (as it well may) experience assures us that Monday-morning quarterbacks will complain bitterly that so much money has been "wasted" on some almost profitless Type B items.

There may be comfort in knowing that if a Type B war comes (and that is a fair likelihood, too), the same critics will complain just as bitterly of the money "wasted" on Type A preparations.

Even in the Aberdeen exhibit of equipment, it will be remembered, there were some items of 1946 design which quite probably are inferior to those of 1956 development—save in one important respect: the 1946 type is proved and in full production, and the 1956 type is still experimental and hence very far from readiness in the hands of using forces.

"That second one ought to come along by 1960," said a research chief. "But if war comes in 1957, we will greatly prefer the 1946 type which is on hand rather than the better type which we can't get into the field for years."

There is no question that lightness, compactness, simplicity, precision, range, power, mobility, and reliability are virtues. So is cheapness. So is readiness for rapid production. The trouble is that it is awfully difficult to combine all those virtues in the same mold; in fact some of them are in perpetual and irreconcilable conflict with each other, and there must be compromise, even to the point of eliminating one of those virtues almost entirely.

WHICH one? And by whose judgment? And how sound is the judgment, and how competent the judge? If he is of unequaled merit as a battle commander, is he any more than fairly good in logistics, and vice versa? Does he have even a smattering of certain new fields of knowledge in technology? Does his research knowledge stop short of proving-ground development? Does he understand how important a consideration these days is cost, whether in money or in time? Is he as aware of the weapons system as of the weapon—that is, does he realize that the item he is appraising is of little use unless it fits neatly into a whole complex system for its optimum employment?

All these questions and some others are involved in the larger question of why some of the admirable exhibits offered at Aberdeen on October 4th seem to have been a long time on the way and why some of them are still in the

experimental stage. As an example, one may note the gun stabilizer of a Patton-tank variant (still experimental, by the way) which gave a really thrilling demonstration. With the tank moving over turf at a 7-mile gait, and the target moving laterally at moderate speed, the gun fired ten shots and made ten hits. That was shooting!

But any one who remembered the German Tiger tank's frequently deadly shooting at us with its own stabilizer 13 years ago (and there were many of the 5,000 A.O.A. observers with memories of exactly that) could not help wondering why after 13 years our own Army is still presenting this American-made stabilizer as an experimental rather than an approved item. The question was put to several research authorities at the Pentagon.

It happens that we did have a stabilizer of sorts as early as 1942, for the M3 and M4 tanks. But it stabilized on elevation, and not on azimuth. There have been numerous projects since then, and that some are still coming is suggested by the fact that the October performance was by an X-type. It is apparent that the man who is making the judgment in this case is exacting, as he should be, but is he overexacting? Or are there other factors at work? A research authority grimly replies that there have been a lot and still are.

"You can start out with the crippling influence of the extreme 'economy' program which started immediately after V-E Day," he said. "It began even before V-J Day wound up World War II, and it continued until Korea. Even Korea did not provide anything like a cure, for while the emergency loosed a good deal of money for research and development, the approved projects were, naturally enough, almost exclusively those visibly useful for the fighting already under way in Korea or for the larger fighting to which it was thought the Korean action might lead.

"AND every approved project was put on a 'crash' basis. That is, we halted a development process right in its tracks and, instead of seeking further improvement which might be right around the corner, we froze the work where it was and went straight into production. That was right enough, for we had to win the war into which we had just been catapulted. But that is the reason that we have had to do so much redevelopment of those same weapons ever since.

"The cost of redeveloping them has exhausted to that extent reasearch and development funds granted us—and more especially the thinking resources —which we would have preferred to apply to brand-new ideas.

"As an obvious example, the Aberdeen demonstration of October 4th included a heavy tank. It is a very good one. But if we are, by present thinking, to concentrate on air-transportability, that particularly good tank is here just in time to be too late.

"While on the subject of tanks, I must recognize that the Army authorities have been particularly hard pressed by conflicting desires. Certain first-class armored commanders, with brilliant records in World War II, made it clear to us that what they wanted was a gun of unparalleled merit. Other commanders just as good made it clear that they wanted a lot of armor, so that their tank forces would absorb punishment and still continue fighting. Yet others wanted long-range capability to make them semi-independent of bases and supply lines. And all of them wanted mobility.

"In other words, the composite demand was for research and development to produce a tank which would meet all those specifications. It would have been as big as a freight car, even without a fuel tank big enough to move it faster than a crawl.

"That is an extreme case, but it illustrates from real experience the difficulty of meeting user-troops' demands within logistic possibilities. It is the perfect example of mankind's tendency to demand something without any shortcomings whatever—and also to explain without argument why the attitude of our evaluation people is important. They must be ready to make harsh compromises—not to get perfection, which simply cannot be got, but to approach the optimum balance."

That money for research and development has been lacking need hardly be said all over again. There is less awareness that time, too, has been lacking, and largely for the same reason. For if there is available only half the money required for a carefully considered over-all ordnance program, there must be a choice between spending half as much on each item in the program (and thus stretching out the time required for each) or putting half the projects on the shelf altogether for another day (and in their case stretching the time out indefinitely).

IT'S hard to tell which is the worse choice. In the former case, you do the development work at a slow pace and actually buy obsolescence. In the latter case, truly valuable projects are lost sight of altogether for years.

Col. Lucian B. Moody (U.S.A., Ret.) might have a word on that subject. He was at Aberdeen in October when the newly completed Mechanical Mule surprised a lot of observers by its efficiency. It aroused other emotions in Colonel Moody, for as the officer in charge of design of combat motor vehicles a generation ago, working under Par. 112, S.O. 289-0, War Department, 1918, he produced in 1920 something very like the 1956 Mule (and his pioneering model could also float).

The choices made at any given time, as to what is to be developed and what is to be shelved or partly shelved (again we are faced with the question of who does the deciding and how wise he is) can be of staggering importance. At this moment, for example, the deciding authority faces the absolute need of full-speed ahead on missiles, and this means not only the long-range and medium-range marvels at Redstone Arsenal, but those of shorter range against both aërial and surface targets which are coming to life at other development centers.

Yet that same authority faces a need, little if at all less urgent, of maximum speed in the development of air-transportable equipment of many kinds. There is no question that missiles and air-transportability are essential. But if enough money and attention are as-

sured to the vital work in those two fields, are we sure that the work in yet other fields is being carried out as vigorously as it deserves?

HOW wise can a man be in looking into the future? How well has the case for these other research items been presented so as to afford an adequate basis for good judgment? If it be still in the paper stage or in the laboratory stage, is its proper evaluation hampered, not because the item is unimportant but simply because the man who is guiding it may not have a gift for arguing his case? That has happened in the past.

Today there are a great many more considerations and factors than ever before, owing to the rush of technological advances, some in totally new fields. It was not necessary for our Stone Age ancestors to convene an evaluation board to decide the right design for a flint ax—any one of them could split a skull in a wholly satisfactory manner. But there has to be standardization for producing a machine gun, and a great many important factors enter the final judgment.

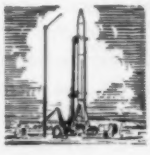
The using forces always want extra performance. That is a prime reason for what seem like ghastly long delays in development laboratories, and also for some ghastly disappointments in the field. For extra performance almost inevitably calls for added complexity. And added complexity almost inevitably leads to unreliability in one or another of the multiple parts or in their adjustment to each other.

All this leads either to added maintenance costs or to larger skill requirements or to sudden failure in operation, often in a crisis. There can be extreme examples of this, such as the fact that, in the case of vital electronic equipment, for every dollar of original cost, two dollars go into the annual maintenance cost. (Nothing like that in the day of the flint ax!)

THUS you face a special factor of judgment. How high a trouble rate are you prepared to accept as the cost of the high performance you demand? Obviously if reliability is zero, there is no virtue in an occasional one hunderd per cent performance. Just how much performance are you prepared to insist on, against how much reliability? And again, how good are the judges involved?

Maintenance costs are important, and it is not only in electronics that they are heavy. A helicopter's initial cost is high; besides that, its maintenance costs thus far appear to run very much higher than in the case of fixed-wing planes. There can be no stinginess about maintenance cost, or down goes the reliability of the helicopter—and the helicopter, too! Yet for all its capital cost and all its maintenance cost, the helicopter serves functions which no other device can perform, and the answer is simple—the costs must be paid. This is true of more than helicopters.

There are outlays on which the overthrifty may look back with regret. Is the 280-mm. gun as indispensable as it was before the arrival of those new missiles which are rapidly replacing tube artillery? Is the first Nike anywhere near as good as Nike B? Of course not, but through the period when we needed those weapons in the field for their very real powers of deterrence, we had them, and thereby we had a large measure of assurance against attack. The fact that they never had to fire a shot in wartime is a long way from being regrettable.



Similarly, a staggering amount of money was spent on the B-36 and on the earlier type of A-bombs with which it was armed. The B-36 was a mighty factor in averting war, and it paid for itself thereby. All these, and other "obsolescent" items, bought us protection for years at a bargain rate. If their successors do no more, again it will be a bargain.

Now just how obsolescent are some of these things, on the ground that they are not air-transportable? Opinions differ, but one must view with respect the views publicly expressed by the Chairman of the Joint Chiefs of Staff in a carefully prepared speech of mid-October before the National Defense Transportation Association, on "Mobility Preparedness." Few are more air-minded than Adm. Arthur Radford, and nobody is more aware of the need for mobile ready forces—air, land, and sea—and hence for weapons and equipment which can be airlifted into a war theater.

YET it is his duty to be just as aware of limitations as of capabilities, and it was these which he noted soberly in his mid-October speech, from which these remarks are extracted:

"I would caution, however, that the strategic mobility we need is not merely a matter of air lift. It is not simply a matter of building more airplanes. We would be wise to avoid the pitfall of regarding air transportation *per se* as the answer to all our problems.

"To begin with, air transportation is not cheap, nor is it always the most efficient and effective means of transporting units, especially large ones, over long distances . . .

"Air mobility requires an airbase network complete with terminals, refueling and repair facilities, . . . services; and each part of this network requires logistic support of its own. Air mobility is definitely affected by the at-the-time status of petroleum products and by the availability of supporting personnel.

"WHEN planners study peripheral areas around the world, they find but few areas where the air-base facilities can take a concentration of forces quickly and then support them logistically. They find even fewer locations where the necessary additional facilities exist for air defense. . . .

"When all these factors are considered, it may well be determined that the bulk of the forces . . . could be moved more expeditiously and easily by means of improved surface transportation. . . ."

This is cautious advice from a respected source, powerful in the Nation's military counseling. It is particularly useful as a reminder of the theme mentioned earlier—that there are several kinds of war and equipment needed for each kind and unending research and development for coping with all varieties.

New Shapes in the Sky

The new Air Force Convair B-58 Hustler delta-winged bomber, above, is designed for supersonic speeds above 50,000 feet. Powered by 4 turbojet engines, it carries a 3-man crew (Air Force photo). The Sikorsky HR2S-1W helicopter, below, equipped with powerful radar, will be used with the fleet to extend early-warning coverage against low-flying aircraft.

Marine Corps Ordnance

The new concept of Marine amphibious operations is designed to exploit our atomic and conventional weapons in offensive action backed up by fast carrier task forces and mobile units mounted in assault helicopters

Maj. Gen. F. M. McAlister, U.S.M.C.

ORDNANCE development today is probably more dynamic than evolutions which are taking place in other categories of equipment used by the armed forces of the United States.

In order to discuss current ordnance problems and considerations as they apply to the Marine Corps, I must first cover briefly the mission and purpose of the Corps.

The Marine Corps today, as one of our armed services, is a part of the Department of the Navy. The Corps is primarily a fighting outfit—organized, trained, equipped, and ready for immediate combat at any time and place.

The Navy and Marine Corps together exist for but one purpose—to ensure that our side has control of the seas in time of war. It should be noted, also, that together they are a powerful deterrent force.

WHILE the Marine Corps provides security forces for combat ships and naval installations, its primary mission is to provide landing forces for service with the fleet in the seizure or defense of advanced naval bases or to perform such other duties as the President may direct.

Today the Marine landing forces, which are the real heart and soul of the Marine Corps, are assigned to the fleets of the Navy and train with the amphibious forces in frequent exercises. These landing forces are called Fleet Marine Forces.

General McAlister is assistant Chief of Staff, G-4, Headquarters, United States Marine Corps, Washington, D. C. This address was given before a recent meeting of the Lone Star Post of the American Ordnance Association in Dallas, Tex.

The naval ships, aircraft, and Fleet Marine Forces that compose an amphibious attack force of the fleet constitute one of the most powerful, unique, mobile, flexible, and self-sustaining offensive forces in the world. No other nation presently approaches the amphibious capability of the United States—and we want to be sure to keep it that way.

The new Navy is a powerful, mobile, flexible, and versatile force in which nuclear propulsion may be more significant than the change from sail to steam. Moreover, the Navy is retaining its capabilities for fighting either an atomic or nonatomic war. The Marine Corps is moving forward with the Navy so that the tactics, techniques, and equipment of the amphibious forces and the Fleet Marine Forces are in concert with, and ever ready to exploit the speed, power, mobility, and versatility of the new naval forces of the United States.

Our new goals have been under study since World War II and have resulted in the formulation of a Navy-Marine concept of future amphibious operations adaptable to small, large, nuclear, and nonnuclear wars.

THE concept which has evolved is designed to carry the war to the enemy homeland. Although it includes defensive measures against enemy atomic weapons, it is designed to exploit our own atomic or conventional weapons in offensive action; to exploit the speed of the Navy and the surprise and heavy effects of strikes by fast carrier task forces; to exploit the teamwork of the Marine air-ground landing force; and to exploit the helicopter in attaining a new order of tactical mobility by eliminating direct assault on enemy-defended beaches.

As expressed by the Chief of Naval Operations, Adm. Arleigh Burke:

"Speed, mobility, and flexibility are the essence of the new concept. We have increased our speed in many ways. We are building faster ships to reduce the time en route to the landing area. We are testing landing craft equipped with hydrofoils which show great promise. We are employing helicopters in increasing numbers to speed up the initial assault and to provide tactical mobility for the troops. The helicopter permits us to launch an

initial assault while our ships are still well out at sea, and it enables us to project naval power, through the Marines, deeply ashore.

"The helicopter permits the Marines to concentrate and disperse rapidly once ashore, and it permits us to keep our ships well dispersed as a passive defense measure against atomic attack.

"Its speed and mobility will facilitate the rapid concentration of Marines to knock out enemy beach defenses and other strong points. It makes virtually any point of the enemy coastline vulnerable to amphibious assault. No longer are we compelled to use only the sandy beaches which can be strongly defended."

COMPARED with the beach assaults of World War II, the new concept seems radical, but it represents no departure from sound principles. When Napoleon's army ran short of food and forage he developed his own maxim: "Disperse to live, concentrate to fight!"

Our new concept includes that same idea, although for different reasons. It is in this maxim that we find many of our basic needs for new weapons, new tactics, new techniques, and improved forms of communications.

To achieve our goal, we must increase our fighting power without reducing our mobility and flexibility. While dispersed, our formations must be controlled and their movements and actions fully coördinated and perfectly timed. Concentration must be fast, flexible, and responsive to battlefield intelligence.

In meeting these broad requirements, we must have comprehensive development programs which never lose sight of the ultimate goals.

We must attain the highest combat efficiency, and at the same time, since our assault forces must be transportable by helicopter, we must not burden them with nonessentials or lose flexibility by an obsession with gadgets.

Simplicity is still a military virtue of the highest value. There is nothing more simple, militarily, than front-line infantry combat where men on different sides are shooting it out with each other.

Here are lacking all the paraphernalia, gear, accouterments, push-button complexities, and technicians that favor the areas farther to the rear. Yet it is around the individual Marines in the leading helicopters or on the front lines that the tide of battle ebbs and flows.

The ability of the individual Marine to "deliver the goods" is the decisive element upon which we depend for success in battle.

Our development programs in the Marine Corps are designed to do everything possible to support and assist the Marines on the front line to win their battles and to do this without adding to the complexity of their problems.

Marine development programs are carried out in a realistic sequence.

In the ordnance area, we work closely with Army Ordnance and the Navy Bureau of Ordnance, Bureau of Ships, and Bureau of Aëronautics to achieve this end.

Some of our special needs in weapons and equipment for landing operations must be met by "starting from scratch"—a statement of the requirement, followed by virtual invention of the device.

Many other needs, however, will be met by contribution of ideas or actual devices from agencies outside the Marine Corps which understand our objectives and which have the scientific or production know-how to assist us.

Amphibious operations of the future will place more difficult requirements on ordnance equipment than amphibious operations of the past. Because of the need for dispersion and increased mobility, weapons must be many times more efficient in their intended combat rôle.

THE logistic problems of an operation in which helicopters are the primary lift from ships to the landing zone will be most formidable. Because of this problem, if we can obtain tactical weapons of greatly improved performance, then we can reduce the gross amount of ordnance which must be placed in the landing area.

In turn, the fewer number of weapons required for a given operation will permit a reduction in the number of Marines which must be lifted, as well as a reduction in the quantity of helicopters which will be required.

Perhaps one of the most grave threats to successful amphibious operations in the future is the enemy's capability to employ air-dropped atomic weapons against our forces. Therefore, we believe that our foremost requirement is to provide weapons and aircraft which will be capable of defeating enemy aircraft before they can reach their bomb-release point.

FROM the standpoint of ground antiaircraft weapons, the Marine Corps feels that conventional gun-type antiaircraft weapons are incapable of accomplishing this mission against high-performance enemy aircraft and that the use of guided missiles offers the most promising solution.

In this advancing field, the Marine Corps is supporting the development of antiaircraft guided-missile systems which will be adapted to the Marine Corps concept of amphibious operations.

In the missile-development area, the most pressing problems are: (1) the long lead time from inception of the system to delivery of weapons capable of being fought in the field; (2) the apparent incompatibility between the simplicity necessary for maintenance and the technical sophistication demanded by improved performance requirements; and (3) the lack of operational reliability engendered again by this same technical sophistication.

The logistic problems are a result of the constant change within the missile systems. However, flexibility and the ability to modify a logistics system to suit technical changes are necessary elements in any weapon system. This is particularly important in the case of guided missiles.

In the past, operational planners have sometimes called for the use of weapons with little regard for the logistical support necessary to make the weapons operationally effective.

Some alteration of this practice must be considered in the use of guided missiles which, as a weapons class, are vastly more expensive than other weap-

ons, not only from the dollar consideration but in respect to the production capacity of the United States.

What can we as users do and what can industry do to face up to these two problem areas?

With regard to development problems, I believe that remedial steps can be undertaken immediately in order to minimize the problems which plague us.

For one thing, we need to suppress the natural desire to go into production prior to system evaluation. This may seem to be incompatible with the problem of long lead time, but waivers to this policy in no instance in my memory have resulted in a shorter lead time.

The problem of simplicity of maintenance versus technical sophistication and the problem of operational reliability can be solved at least partially by having each individual working in the development program ask himself: "Is this the simplest solution for the problem?"

AN objective application of this criterion throughout all phases of development would obviate the tremendous maintenance problem already evident in some of this equipment and will markedly improve its reliability. For the logistics problems involved, a partial remedy is the establishment of training programs for surveillance and maintenance personnel to ensure that the capabilities of those responsible for the weapon components, all the way from the manufacturer to the operating units, are abreast of changes in equipment.

With respect to Marine Corps requirements for ground-to-ground weapons and equipment, the overriding consideration is reduction in weight and size. Moreover, improved performance of such matériel will permit a reduction in the quantity of these items.

Present-day artillery weapons are inherently disadvantageous because they are of the "cannon" type, with heavy trails, carriages, and recoil mechanisms. For example, the most common weapon, the 105-mm. howitzer, weighs 4,900 pounds, and one round of its ammunition weighs 42 pounds.

"Amphibious operations of the future will place more difficult requirements on ordnance equipment than amphibious operations of the past. Because of the need for dispersion and increased mobility, weapons must be many times more efficient in their intended combat rôle. The logistic problems . . . will be most formidable."

We can move on up the ladder of field artillery weapons to the towed 8-inch howitzer and its prime mover, weighing a total of 33 tons and firing a 230-pound round of ammunition.

The Marine Corps foresees a possible solution to this problem of weight in the development of ground-to-ground guided missiles and rocket-assist-type artillery weapons and projectiles which eliminate the problem of recoil. Savings in weight and size are achieved, although some degradation in accuracy may result.

Our problem then, is to develop a weapon embodying the best features of cannon-type artillery weapons with the desirable characteristics of rocket and recoilless-type weapons. In this manner we visualize the development of an optimum type artillery weapon suitable for transportation by helicopter in amphibious operations of the future.

In the antimechanized field we are searching for highly efficient, lightweight weapons, such as an antimechanized guided-missile system, which will be able to defeat an enemy's armor before he can effectively bring his weapons to bear on us. In achieving this end, we may have to forego the high degree of armor protection which we enjoyed in the past in order to achieve the necessary mobility.

In the wheeled-vehicle area, we require lighter, helicopter-transportable trucks such as the Mighty Mite, which the Marine Corps is currently developing. The Mighty Mite weighs only 1,700 pounds as opposed to the 2,750 pounds of the standard jeep.

The same pattern of requirements holds for infantry weapons. We are trying to lighten the individual load of the Marine so that he will be more effective in highly mobile combat.

In a few years we expect to be equipped with rifles, machine guns, and mortars which will be at least twenty-five per cent lighter in weight.

As far as total weight is concerned, hardly any type of military supplies is more significant than ammunition. Here we desire to obtain the lightest possible ammunition consistent with such factors as range, accuracy, and lethality.

IN Marine Corps aviation ordnance requirements are generated by two primary tasks—air defense and air support. In the air-defense rôle, these requirements are conditioned by the vastly increased speeds of aircraft which necessitate a weapon that will ensure a lethal hit during the very brief time the aircraft is in proper position to fire on an enemy target.

Our principal weapon for air-to-air combat is still the machine gun and the 20-mm. cannon. Developments to increase the cyclic rate of these weapons show promise of improving their effectiveness and useful life.

In addition, we are vigorously pursuing developments in air-to-air rockets and guided missiles, and recently some of our aviation units have been equipped with an air-to-air missile.

The close-air-support mission of the Marine Corps calls for a family of weapons: *machine guns* for strafing personnel and light surface targets; *rockets* for pin-point targets such as tanks; *bombs* with high-explosive and atomic warheads; and air-to-surface *guided missiles.*

OUR goal of achieving this air support under all weather conditions and in extremely close proximity to friendly troops calls for weapons with the highest order of accuracy and reliability.

In conclusion, I would like to reiterate that the Navy and Marine Corps have established a set of objectives and requirements for future amphibious operations and that we are making progress toward the goal.

Armor Penetration

The study of the penetration of armor has interested ballisticians for many years, but only recently clearer concepts have arisen due largely to a new approach to the basic problem and to advances in the related sciences

Dr. Melvin Zaid and Burton Paul

RECENT articles in this magazine and elsewhere have underscored the necessity for the development of light mobile armor as well as for means of defeating both light and heavy targets. These projects and many others of a vital nature would be greatly facilitated by a thorough understanding of the mechanics of armor penetration.

Although the study of armor penetration has engaged the attention of ballisticians for a great many years, surprisingly little progress has resulted over the centuries. Recently, however, clearer concepts have been arising from a sea of accumulated empirical data. These new concepts are due in large measure to a new approach to the basic problem, as well as to advances in related sciences such as the theories of elasticity and plasticity.

THE fundamental problem in the theory of armor penetration has not changed appreciably since the invention of cannon and shot. This problem, succinctly phrased by Leonardo da Vinci, is the determination of "the power of the bombard and the resistance of the object struck." The analytical tools required for the solution to this problem did not exist in Da Vinci's time, but with the formulation of Newton's laws of motion and the invention of the calculus it became possible to attack the problem by rational methods.

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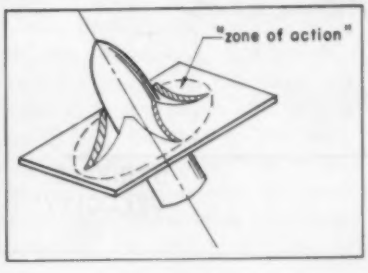
Since the earliest projectiles studied were nondeformable cannon balls, it is perhaps natural that the projectile was assumed to be a "point mass" or a single particle. If the forces acting on the particle could be determined, then the complete mechanical behavior of the projectile could be predicted by Newton's laws of motion. Thus the explanation of penetration phenomena became firmly associated with the search for the correct relationship between resisting force and penetration distance.

The simplest possible law of resistance was advanced by the English ballistician, Robins, in 1742. Robins proposed that the resisting force, for a given projectile-target combination, be considered constant throughout the entire penetration process. Three years later, in a German translation of Robins' work, one of the most productive mathematicians of his time, Leonard Euler, elaborated upon Robins' ideas and gave some experimental values for the constant resisting force of elm wood and earth.

Fig. 1. The momentum approach which confines effects within a "zone of action."



ALTHOUGH capable of establishing some correct "order of magnitude" results, the Euler-Robins law is too crude to be of much practical use, its major defect from a theoretical point of view being that it neglects the instantaneous conditions of the phenomenon.

The theory remained essentially unchanged for almost a century. However during that time significant advances were being made in the study of fluid resistance, where a "quadratic resistance" law was noted in many instances. This undoubtedly influenced the thinking of terminal ballisticians.

In 1829, J. V. Poncelet published a theory in France which combined the Euler-Robins type resistance with a resisting force proportional to the square of the velocity; that is, the resisting force was assumed to consist of two parts. The first part, corresponding to the Euler-Robins' constant term, represents, in Poncelet's words, the effect of "breaking the bonds which are responsible for the cohesion of solid or

semisolid material," and the second term, proportional to the velocity squared, is a measure of the projectile energy "supplying the resultant detritus with the kinetic energy required to get it out of the path of the bomb. . . ."

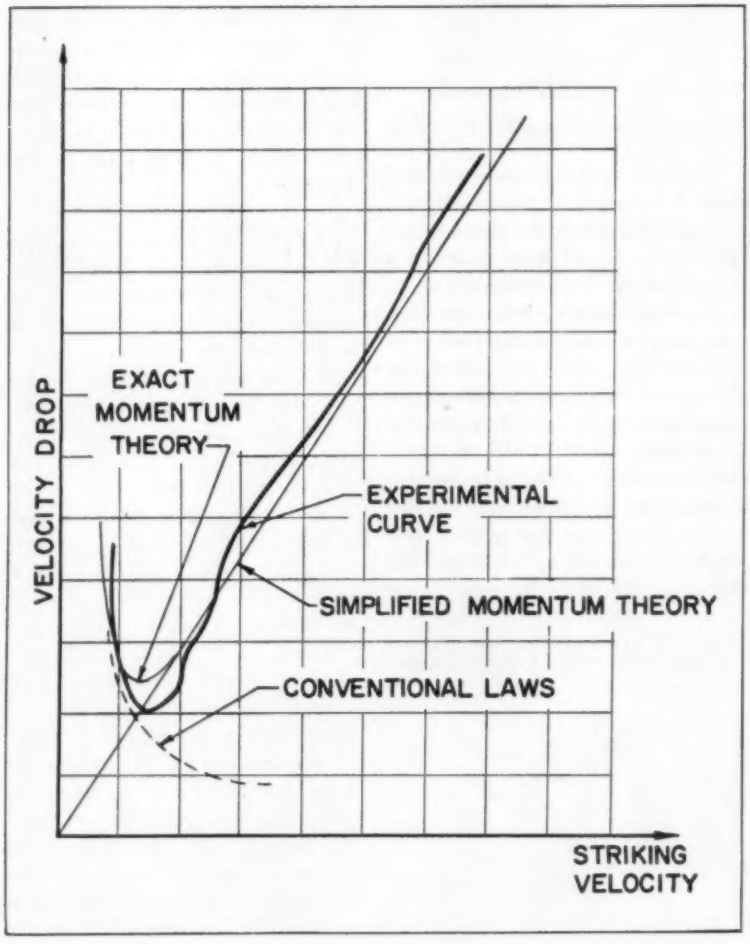
PONCELET'S theory, with a slight generalization, has remained up to this day the most widely used penetration law by workers in the field of terminal ballistics.

Although capable of explaining some penetration phenomena, the Poncelet law requires the determination of at least two numerical coefficients, which, at the present time, are obtainable only by extensive firing tests. Each particular projectile-target combination requires individual experimentation, as do the various combinations of striking velocity, angle of obliquity, etc.

Along these lines a considerable amount of experimental work was performed by contemporaries of Poncelet in France. The data collected pertained to a wide variety of target materials, including clay, limestone, sand, brick, and various kinds of wood. These century-old data are still relied upon by present-day ballisticians.

However, such data, no matter how extensive, cannot be expected to cover all probable ranges of firing conditions and are in fact restricted to normal impact against thick nonmetallic targets. For this reason information of this type is obviously of little use in problems involving armor-plate penetration, particularly if the plate is thin. Thus the practical application of the Poncelet law leaves much to be desired from both a theoretical and a design point of view.

Fig. 2. Velocity drop versus striking velocity.



The Poncelet law and its limitations are characteristic of the "energy approach" to problems of terminal ballistics. Basically the energy approach attempts to evaluate all the separate modes of energy dissipation associated with the penetration process. The difficulty of such an approach becomes apparent when one attempts a detailed analysis of such complex problems as the determination of the elastic energy due to wave propagation, energy of crack formation, energy due to plastic wave propagation and plastic deformation of the target, energies due to friction and heating, strain rate effects, etc.

THEREFORE any attempt at the solution of the penetration problem using the classical methods outlined above must inevitably lead to the consideration of a multitude of complicating factors.

In seeking to overcome these basic deficiencies of the so-called "classical theory" the authors have approached the problem from the "momentum point of view" rather than from "energy" considerations. It is interesting to note that the question of "energy" or "momentum" has been debated vigorously by mathematicians in the past.

One famous eighteenth-century controversy was finally ended by D'Alembert in his famous treatise on Analytical Mechanics, where he showed that neither energy nor momentum has any *a priori* superiority as a measure of resistance but that they are merely alternative methods of describing the same phenomenon—in some cases one or the other being more convenient.

THE momentum approach utilizes the fact that waves of disturbance propagate at a finite rate, so that during penetration of a target the significant effects are confined within a "zone of action," as indicated in Figure 1. Applying the principle of conservation of momentum to the entire system within the zone of action, the instantaneous velocity of the projectile can be completely described in terms of a quantity known as the "effective mass" of the target plate.

When the instantaneous velocity of the projectile is known, then the ac-

celeration, penetration distance, and resisting forces may all be computed in a straightforward manner. Thus the complete mechanical state of the projectile is predictable, and one of the problems of terminal ballistics is solved in terms of the "effective mass."

THE physical and mathematical considerations entering into the determination of the effective mass will not be discussed here, but some of the more interesting results of the foregoing analysis will be presented.

Of particular significance is the determination of the velocity drop experienced by a projectile upon complete perforation of a target plate as a function of the striking velocity of the projectile. Information of this nature finds many applications in problems of fuzing, safety, and arming.

A typical experimental curve is shown by the heavy line in Figure 2 for a projectile penetrating a relatively light target plate.

It is noteworthy that the "conventional" theory, shown by the broken line, fails to describe the process adequately for high values of striking velocity. This conventional theory is based upon a modified form of the Poncelet law and requires a limited amount of experimental data before it may be applied. It it true that the generalized Poncelet law may be made to fit fairly adequately any given experimental curve, but a large number of firings are necessary and changes in target thickness or projectile shape cannot easily be accounted for.

ON the other hand the exact "momentum theory" as shown by the light unbroken line continues to represent the phenomenon accurately over a wide range of striking velocities. At the present time research is being devoted to the exact "momentum theory" in order to eliminate the necessity for any trial firings in its application.

It has already been determined that a simplified momentum theory gives excellent correlation to experimental data at high striking velocities. This simplified theory requires no experimental firings whatsoever and may therefore be used as a design criterion.

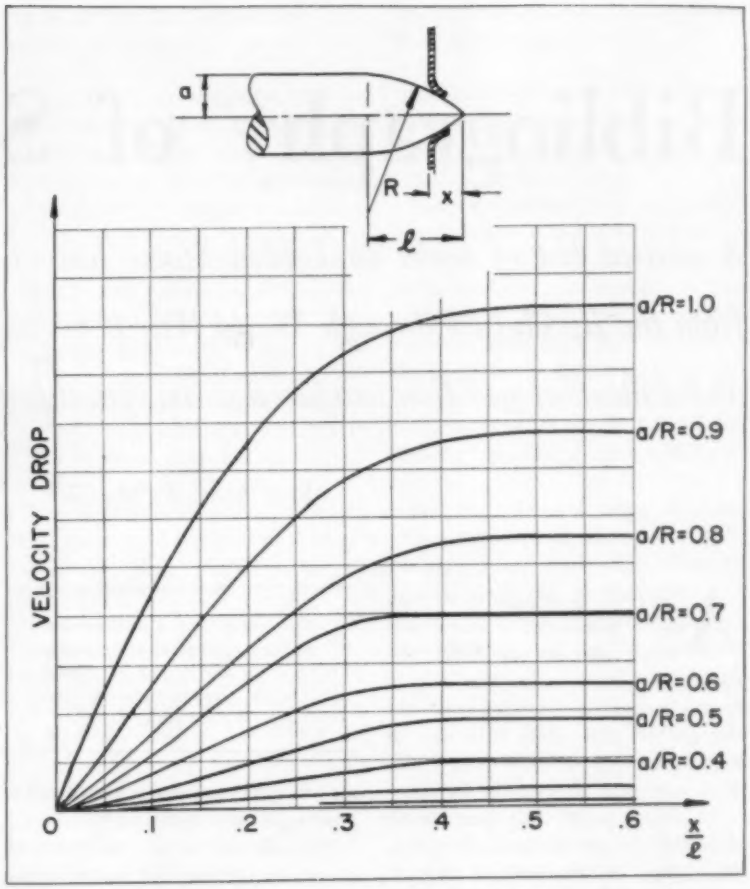


Fig. 3. Velocity drop vs. penetration distance for ogives penetrating thin plate.

In addition, the simplified theory may be used to compute the forces acting on the projectile during penetration. It is also noteworthy that the entire behavior during the penetration process may be charted as shown by Figure 3, illustrating the effect of projectile shape at any stage of the penetration process.

Results such as those shown in Figures 2 and 3 not only indicate the utility of the momentum approach as a fruitful research tool but illustrate as well important practical facts—for example, the existence of a minimum velocity drop, the independence of the projectile behavior at high velocities from the strength of the target material, and the existence of a "separation point" (analagous to that occurring in fluid processes) where the target material separates from the surface of the projectile due to its own kinetic energy.

Many such facts have been noted experimentally in the past, but since the behavior at high and low velocities is so anomalous and since the influence of projectile shape and durability has tended to obscure the basic processes involved, much confusion has existed.

Only when experimental data can be assimilated into the general matrix of a theory can it have meaning and utility beyond the narrow confines of the particular test conditions.

THE methods outlined above are capable of extension to problems of penetration at angles of obliquity and to deformable projectiles. They can also be made to include and explain certain thermodynamic effects. But primarily they are intended to show the power of a new approach in terminal ballistic studies which should lead to important advances in the future design and performance of both projectiles and armor.

Bibliography of Sea Power

A selected list of books on United States history, battles, and biographies from the Revolution through World War II to give professional Navy officers and students of maritime warfare a source of authoritative background material

Rear Adm. E. M. Eller

A NATION'S strength flows from many founts, yet a special one comes from the sea. Before the dawn of history when the mighty waters seemed to be filled with the strength of gods, some men saw, at least dimly, that man and nations likewise gain great power from the sea.

This is a power that goes deeper than the splendid analysis of Mahan. He shows the fundamental requirements for strength at sea and the far-reaching influence of sea power on nations' destinies. Yet even Mahan did not probe something more profound and mystic—the tendency of the sea to shape the spirit. On the one hand it draws forth courage, discipline, teamwork, resilient persistence of struggle to a goal. On the other hand, it breeds freedom.

The ancients caught glimpses of these vital powers flowing from the sea, so any list of books on naval history should begin with Homer's mixture of stirring legend, fiction, and history of amphibious operations.

One of the noblest works ever put into words (and to my mind the best history yet written) is Thucydides' History of the Peloponnesian War. It is the story of the struggle between two opposing philosophies of government that issue from the spirit of man himself. On the one hand are arrayed a people who gained material, spiritual, and military power from the sea and became a democracy of free men; on the other, a people who gained power from rigid state discipline.

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The division is not that clear, of course, for Athens had slaves, as was the custom then, and Sparta turned to the sea temporarily with her own ships and those of allies for added power to fight Athens. However, in spirit the division is there. And it is the division that in a general way has spread across the history of man.

Nations that have depended upon the sea for their strength have tended to be defenders of freedom. Those that have put their primary faith in vast armies have tended to end, if they did not start, as extollers of the state and enslavers of the citizen. History spreads examples across all its pages. We, of course, live as part of the latest one. Therefore, all Americans should strive to understand that part of our strength which derives from strength at sea.

If limited to only three authors to help in this understanding, I would name without hesitation:

(1) Homer—the epic poet of man's great soul in struggle against the sea; (2) Thucydides—the historian who probes into the innermost forces motivating man; and (3) Mahan—the penetrating analyst of the influence of sea power on history, an influence that steadily increases in the Atomic Age.

If I should add a writer now living, I would choose Samuel Eliot Morison. I would do this for good reasons: He is a scholarly writer who seeks accuracy. He knows the sea and the Navy and knows how to write of them with the dash and fascination that they inspire. His account of the greatest sea struggle in history, the exploits of America's Navy in World War II (first ten volumes now in print), is filled with stirring accounts and insight into the meaning of sea power to national destiny.

If one can read beyond these books, he will find many good authors and some fine ones writing in many fields relating to the sea. In 1943, Prof. Charles Lee Lewis, an indefatigable and able biographer of naval leaders, published his "Books of the Sea." Chapters in this book discuss and list works in such areas as the short story, drama, poetry, novel (don't miss "Moby Dick" and "Typhoon"). Other chapters deal with those aspects of the sea more directly related to sea power, such as naval history and the Merchant Marine.

There have, of course, been numerous books of the sea written since then, some of them superb. These are covered to a considerable degree in a list pre-

pared by the Office of Naval History before the author became part of it. This draft, now in the hands of the printer, provides a selected bibliography of naval history. It does not seek to be exhaustive. It lists many excellent works, a number of which are noted in the following bibliography together with a few of my additions.

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This is the second in a series of three articles designed to give the military student a reading guide to books of history, current developments, and reference that will be of value to him in his professional tasks. The first article, "Air Power Literature," by Brig. Gen. Dale O. Smith, U.S.A.F., appeared in the November-December 1956 issue. A subsequent article will list works of especial interest to Army personnel.

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TO serve its purpose best, this bibliography had to establish limiting areas. Hence the student will find readable works outside the bibliographical classification. Among these are the writings of Bernard Brodie, Harold Sprout, Fletcher Pratt. For the broader history of sea power and its expanding influence upon the fate of nations, one can find many able writers.

If any one is making a serious study of sea warfare and its effects on history, he must also read some of the great classics dealing primarily with land operations as well as nonmilitary histories. These are covered in other articles published in ORDNANCE, so I will not attempt to list them.

I must mention, however, Clausewitz and Du Picq. To understand fully the reaction of men in war, and thereby to be a true leader or interpreter of military events, I believe every one should read their books.

Power and Prejudice

If we are to maintain an effective military establishment, the public attitude that has swung between scorn and adulation must be replaced by a more intelligent understanding of our national defense forces

William V. Kennedy

THE decade 1945-1955 marked a major turning point in United States military policy. We came out of a great war victorious. Then, as was our custom, we proceeded to knock our military machine apart. Less than five years later, we found ourselves in a wild scramble to collect and rebuild the rusting pieces.

Not only have we been forced to rebuild a formidable war machine, but we are faced with the prospect of maintaining it, perhaps for as long as this Nation exists.

The lives lost in Korea as a result of excessive military cutbacks and the financial cost of rebuilding our discarded World War II military power, added to all the similar experiences in our past history, total a grim and bloody sum.

Considering the drain these follies have produced on the American people and on the resources of the land itself, it would seem that the time has arrived for a change in our basic military philosophy.

From colonial days onward, American military policy has been dominated by powerful national prejudices. Among these are:

(1) A vague antimilitarism that sees the Military Establishment as a Praetorian Guard, ever anxious for the opportunity to seize the government and subvert its institutions; (2) The belief of a great many Americans in a phantom called "The Military Mind," an inflexible, autocratic, basically stupid outlook on life with which every professional soldier is supposedly endowed; and (3) A conviction that men who make a career out of the service do so because they "can't make a living in civilian life."

Mr. Kennedy is an officer of the 104th Cavalry Regiment, Pennsylvania National Guard. He is former executive editor of the Pennsylvania Guardsman magazine.

In recent years the older prejudices have been joined by the belief that present military developments are all too confusing for the average citizen ever to be able to understand.

Contrast all this with some equally pronounced American characteristics: (1) An almost inordinate love of military ceremony, pomp, and display; (2) A tendency to deify military heroes; and (3) The assumption in time of war by the man on the street that he is an expert on tactics, strategy, equipment, and organization—this after he has studiously ignored exposure to such subjects for the preceding twenty years.

One can understand the confusion that might result on the part of the soldier who, having been berated one day as a martinet, a militarist, and a glory hunter, turns a corner the next day to find his berater decked out in a bright-hued satin uniform, complete with plumed shako, blowing a bugle and performing a precision drill that would turn the Coldstream Guards green with envy.

As might be expected, these contradictory habits and emotions have made our military policy one of violent shifts from one extreme to another.

WE have heaped scorn and ridicule on the military in peacetime, only to exalt them beyond all reason in time of war.

We have kept the national Military Establishment weak in peacetime to protect our democratic system and then have placed that system in real jeopardy by a panicked, headlong rush to the other extreme when danger threatened.

We have reduced the military budget in time of peace to save millions and have wound up spending billions in time of trouble to make up for wasted time.

We have fought fiercely against the "regimentation" of our youth in the training camp in time of peace, only to send that same youth to die or be maimed on the battlefield, inadequately trained and equipped.

We have disarmed to show the world our good intentions, only to convince our enemies that they could advance unopposed.

Out of all this has come a great self-delusion. Somehow, we have convinced

ourselves that we are a mild people who hate everything about the military life and its trappings.

Our love for the panoply of marching men and martial music, however, is a manifestation of a deep-down militancy.

We have criticized the European powers for a long history of conflict. And yet, each time our own interests have been threatened we have reacted with such violence as to utterly ruin the enemy who opposed us.

The present level of our military preparations indicates that we may, at last, have learned the disastrous lesson of military feast and famine.

THE change with which we are most concerned here, however, is in the basic American attitude toward military service and the military profession. If we are to maintain a large military establishment, then the old attitude that swung between scorn and adulation must be replaced by a more intelligent and workable understanding.

The first prerequisite to this, as to any understanding, is knowledge—knowledge of our military institutions and of what makes them work. We must come to know ourselves and the country we have created.

It seems incomprehensible that the average American could spend more each year for national defense than for rent or food—and yet know less of how and why his defense money is spent than of how the school board spends his much smaller school stipend.

The answer is, of course, that the activities of the school board can be followed by reading a few news stories a year in the local newspaper and by questioning local officials in person. The problem of keeping informed on national defense is somewhat more difficult.

If a solution is to be found to the general ignorance and disinterest that prevail among millions of Americans concerning military affairs, then a great deal more emphasis must be placed upon military affairs in our schools—from high school through college.

The high-school graduate, and most certainly the college graduate, should have a sound knowledge of the operation of the Department of Defense. He should be familiar with the military problems that face the United States at any given time and of the means being used to counter or to solve those problems.

Television, radio, magazines, books, and newspapers provide any American who can hear or read with the means of keeping abreast of military developments and of forming judgments that can be applied at the polls.

Once the citizen has been equipped with a fundamental knowledge of the military establishment and has expanded that knowledge by study and observation, the task of establishing a sound understanding between the civilian and military worlds will be accomplished.

No man who knows what goes into the operation of a heavy bombardment wing can regard its officers and men as robots, incapable of thinking or acting for themselves.

No man who has seen the executive ability required of a successful tank or infantry company commander could doubt that man's ability to make his own way in civilian life.

Most important of all, a comprehensive knowledge of military organization, methods, and problems would eliminate much of that searing, blanket criticism which has so often been directed at the military in this country without forethought, without accurate knowledge of the situation, and, hence, without justice.

There are bound to be many areas in an organization of some four to five million men and women, military and civilian, that will justify criticism. The advantage of an informed public is the ability to discern those areas that deserve criticism and to spare from corrosive, demoralizing blame those who do their job honestly and efficiently.

An increased civilian awareness of the scope of the military operation and its problems would benefit the services no less than the civilian population.

All too often the prevailing ignorance of military standards and procedures among so large a part of our citizenry has been the cloak for the mediocre and the shirker within the military family. A public which is fully aware of what is to be expected of each officer, enlisted person, and civilian in the Military Establishment will automatically put a tremendous and continuing pressure on every level of that establishment for the elimination of the unfit.

The gap of understanding that now exists between the military services and a large part of the public must be bridged from the military side as well as from the civilian.

The armed forces of the United States can take pride in the number of officers and men who have developed a profound knowledge, not only of their own profession, but of the world around them.

The aim of the American public and its Military Establishment must be a solidarity of purpose and an understanding of the relationship they bear to each other. This can be achieved only by a constant effort on the part of both the civilian and the soldier.

WE can no longer afford to treat the armed services as the stepchildren of the Nation. Tens of thousands of young men, needlessly sacrificed, and billions of wasted dollars should have taught us by now that the idea of transforming a military acorn into a mighty oak overnight without a terrible penalty being exacted from the Nation and its people is a hallucination.

If our democracy is to reach its fullest maturity—if it is to avoid the pitfall of hero worship that destroyed Rome—then we must find a solution to the problem of maintaining a large military establishment as a component and healthy part of a free society.

There is only one road to such a solution—the road of study, of honest discussion, of patience, and of faith in the Christian, democratic ideals which have made this Nation great. The civilian and the soldier must travel that road together, united in understanding, in purpose, and in the common bond of citizenship.

From Gatling to Vulcan

Some reminiscences of experiments with an almost-forgotten weapon that helped to develop the new power-driven, power-fed, revolving-barrel aircraft cannon which gives our fighters amazing firepower

Lieut. Col. Melvin M. Johnson, Jr.

RECENT publicity on the 20-mm. Air Force Gatling gun, called the "Vulcan," has been noted with interest, more especially the recent article on this weapon in the September-October 1956 issue of ORDNANCE ("Return of the Gatling," by Lloyd Norman, page 361).

Now that the Air Force Gatling has been declassified to such an extent I am prompted to submit some of the background for purposes of general interest and for possible stimulus of future ordnance research.

In the ORDNANCE article, mention was made of my former company, Johnson Automatics, Inc. The article suggested that the Johnson organization had something to do with testing the power-driven Gatling system.

Coming not as a stranger to the Gatling system, it is interesting for me to recall several events in the Gatling cycle which led to its aircraft development program, 1946-1956.

During 1945 the Small Arms Branch of the Army Ordnance Research and Development Service was especially interested in high-cyclic-rate machine guns or cannon of calibers .60 and of 20 mm. for aircraft. Col. R. R. Studler was then chief of the branch, and on his staff was then Maj. Cleves Howell—another "gun bug."

"Doc" Howell cornered me one day in 1945 and suggested that the old Gatling should be tried out with a power drive for calibers .60 and 20 mm., aircraft adaptation. We were in a car in Connecticut en route to solve some belt-link problems for ground guns at a Waterbury contractor's shop.

Colonel Johnson, Ordnance Inactive Reserve, is a well-known automatic arms expert, inventor, and author.

I recall making some pungent points about belt links in a power-driven Gatling! I also noted that the late Dr. Richard Jordan Gatling had already fired an electric-drive Gatling just before his death in 1903. (Nothing new under the sun?)

"Doc" Howell persisted, and I, having been on the "it can't be done" end, not once but many times, took pleasure in sadistically belittling the Gatling for aircraft. Actually in 1945 the Gatling violated many hard-and-fast military requirements. For example, it was not self-operated or self-fed. These were requirements over which I had struggled with some pain for the Office of Scientific Research and Development during 1942-1945.

However, the idea of hearing an old .45-70 Gatling fire a power-driven burst appealed to me, as did the thought of bucking stated, and often obsolescent, military requirements—one of my favorite activities since 1936. Colonel Studler listened patiently to the story, then gave his personal and official support to a feasibility study plus firing investigation of a power-driven Gatling. This went as a contract to my company, Johnson Automatics, Inc., as noted in the reference article.

WRITING the evaluation and projecting all the problems visualized was easy. But we had much trouble digging up a Gatling in shooting condition and an Accles feed (103-round drum). At last we found a 10-barrel Gatling, and we fixed an Accles feed.

Late in 1945 we rigged up a power drive and prepared to fire at our test range in Cumberland, R. I. I regret now we took no pictures; even more do I regret that René Studler and Cleves Howell were not able to be present when we fired, due to other duties.

We arranged the motor to give a cyclic rate of 3,800-4,000 rounds a minute on one try and 5,500-5,800 rounds a minute on the second try. This was a 10-barrel .45-70, model 1886 Gatling. We loaded the Accles feed with fifty rounds, letting the feed run up to speed on the first fifty-three, empty.

Those two bursts of fifty .45-70 black-powder 500-gram cartridges, at some 1,350 foot seconds, sounded like just one "BLAWP, tinkle, tinkle." There was, of course, quite a cloud of smoke. The patterns at one hundred yards were excellent. The "tinkle" came from the empty cases.

We finally had an extractor casualty, but I am still amazed at the performance of that 1886 Gatling—5,800 rounds a minute for 50 rounds clocked electrically. The gun was probably amazed, too! Dr. Gatling had achieved a rate of some 3,000 rounds in 1903, so he would have gotten quite a kick out of this 1945 test, for this was almost double the speed he attained with the gun.

Winchester acquired the gun and feed in 1949. It now reposes in the arms museum of Olin Mathieson Chemical Corporation where I not infrequently view it with affection and ineradicable memories.

These firings, together with other data and analyses, were embodied in my feasibility report to Ordnance. I made reference to electric power and "clutch" needs for a belt-fed aircraft gun, noting the special qualifications of several large companies in these fields. The project was thereafter given to the General Electric Company by Ordnance in 1946.

I did not see the "Gat" again, in any way, until 1951 while serving the Research and Development Board. Its sound was not then nor is it now unfamiliar. Actually it sounds like a high-speed outboard motor without a muffler. I am reminded of an old Ordnance verse which from memory goes: "Where battles yet unfought are won, by test shots from a single gun."

I should like now to submit what I regard as some lessons learned for ordnance and industrial research in the Gatling saga.

Here is a weapon system which existed a century ago; which was actually "demonstrated" by Gatling's staff in the Civil War; a weapon which General Custer refused to carry when he led elements of the immortal 7th Cavalry to slaughter at the Little Big Horn. It was used in such calibers as .50-70, .45-70, .30-40, .30-06, and several small cannon calibers—up to one inch by several nations. It was power-driven by Dr. Gatling in 1903; gave its name, "Gat," as slang for a gun; and was completely abandoned early in the twentieth century. In fact, for the 1945 test, I could not find anywhere even one caliber .30-06 or one caliber .30-40 Gatling, of the period 1896-1910.

Instead we had to use one of 1886 in .45-70 with a 103-round repaired Accles feed.

Yet this weapon system is now highly praised by the U. S. Air Force for its most supersonic jets.

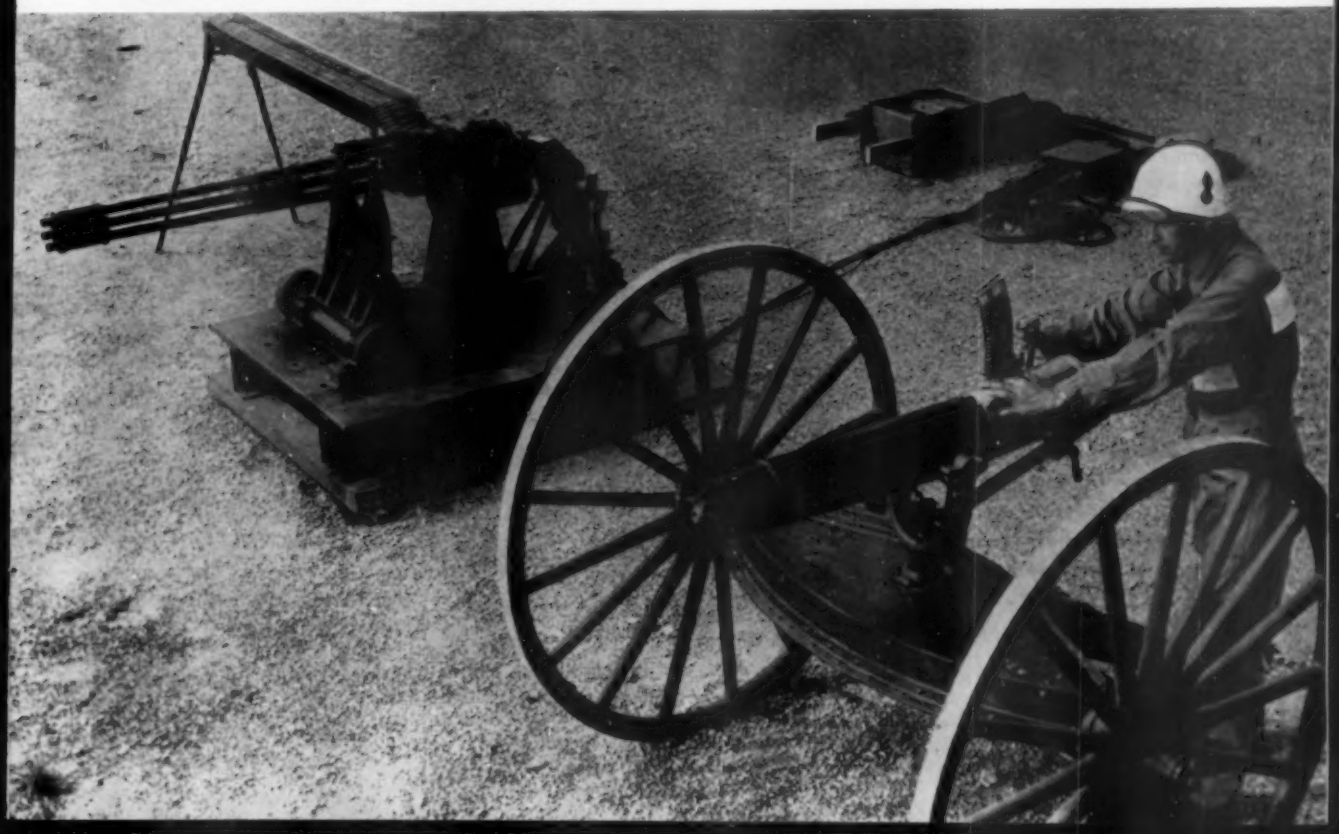
Lesson One is that we should save *working* samples of all weapons; that we must evaluate a weapon system on *functional* grounds, whether new or old; that weapon age is rather incidental, because prior experience and use are not handicaps in functional evaluation.

Thus we find knives still used in combat. The revolver is over a century in age as a system—what police officer does not carry a revolver? This, as with the Gatling, is because of functional application. The system works! It is applicable because it is reliable, not necessarily because it is old. This is true also of the venerable Winchester .30-30 carbine, Model 1894.

THE next lesson is noted in development time. Cleves Howell batted out the Gatling idea for aircraft in the fall of 1945. I fired the experiment and wrote the report by the turn of 1946. Colonel Studler signed up General Electric between January and June 1946. Most of this lag was procedural.

The basic system certainly was not new. But the feeding was new, and the speeds of fire were far beyond those

The new "Vulcan" fast-firing, 20-mm. aircraft cannon, left, is shown with its famous 19th-century predecessor, the Gatling gun, patented in 1862. Both weapons have a cluster of rotating barrels to increase cyclic rate (Army photo).



of the old Gatling. It has been ten years in development, but the Gatling traveled a rough road during 1946-1956. There were some years when the Vulcan project looked like a lost cause on the research budget.

Lesson Two is this: You should and can develop such an item in much less than ten years—but only if you really follow through on the whole program. Moreover, the Gatling story teaches us that our weapons developments can, and for our survival must, have no association with the monthly ups and downs of international or even national affairs.

Note that the Vulcan project commenced just as we had defeated our enemies of the Second World War. "Why develop a new gadget when we have just beaten two enemies with old gadgets?" So the lesson is that peacetime is research and development time —that "development never ends."

The third lesson relates to what are called military requirements or characteristics. Every service is tending now gradually to shy away from these because the users are being faced with so many new and novel needs. Moreover, in the past there have been many instances where military requirements were one or two wars behind the current war.

FOR example, aircraft machine guns for World War II airplanes were "required" to be not more than 20 mm., self-actuated, self-fed, and of silhouette consonant with wing installations in prop-propelled aircraft. A most concise set of military requirements could be prepared along those lines—and were!

So Cleves Howell was driving with me on a Connecticut highway to battle with a belt-link problem, and he wanted to try a *power*-driven and *power*-fed Gatling, thereby violating all that was then sacred in aircraft machine-gun military requirements, to say nothing of the silhouette!

I need not describe here the changes in aircraft structure, design, space, speeds, fire control, and air tactics involved. For this purpose the Vulcan acceptance is an answer.

Much has changed in aircraft during the past decade, and it is noted that in the obituary of the late Gen. Jacob Fickel, who died in 1956, reference was made to his part in demonstrating how a *bolt-action rifle* could be fired from an airplane in 1911. The Wrights flew General Fickel for the demonstration.

So Lesson Three suggests that we steer away from "requirements" and search for "goals." The first goal is, of course, peace. Short of that the Gatling teaches us that there is much value in supporting high cyclic rate per minimum of pound capability as a "goal" without tag-tailing onto the program a flock of last-war requirements.

Military goals must be understood as that which we hope to approach—but never quite reach. Our vehicle will be imagination, powered by aptitude, flexible procedure, understanding, and experience. If we lack these there will be no development in the terra-celestial sphere of our today or tomorrow. Let us therefore strive for "military goals," not "requirements," for the future.

The fourth lesson from the Gatling is adaptation. This is not merely because the Gatling is old but because it represents an unusual contribution to development, one which now appears in the Vulcan; yet none shall deny that development never ends.

Those who dedicate themselves to development well know the meaning of merger; that is, the merger-marriage of known and experienced elements into a specific weapon. The Vulcan constitutes a most notable example of such a marriage, coupled with the reincarnation of a weapon which was demonstrated at Gettysburg during the Civil War and which Custer left behind en route to the Little Big Horn.

"Here is a weapon system which existed a century ago; which was actually 'demonstrated' by Gatling's staff in the Civil War; a weapon which General Custer refused to carry when he led elements of the immortal 7th Cavalry to slaughter at the Little Big Horn. It was used in such calibers as .50-70, .45-70, .30-40, .30-06, and several small cannon calibers—up to one inch by several nations. It was power-driven by Dr. Gatling in 1903."

LESSON Four suggests use of adaptable elements because they are adaptable, *not* necessarily because they are historical. But Lesson Four also teaches us that a combination of known and substantiated elements often can give us a more rapid and practical system than a merger-marriage of muddled mysteries.

The fifth lesson is purely technical and beautifully brief. You cannot beat down a sound basic system. Consider the wheel, the hammer, the stone-age hatchet, the knife.

THE sixth lesson is that procedure, the potent pattern of organization, is "shot down," in Pentagon patter, by the Gatling Vulcan. Again, speaking not as a stranger, I know, even from memory, how many times procedure nearly gobbled the Gatling.

During 1946-1956 the Gatling encountered much more procedural than technical difficulty. But sounding, may I repeat, like an outboard motor without muffler, the Gatling prototypes gave sufficient rhythmic music to impress the most uninitiated administrators. Its stoppage record, per number of models and rounds fired, also lends outstanding technical support to its triumph over procedures.

The lesson therefore is: Adapt procedures to development needs, not development to procedures. Lest there be doubt, consider the history of the law, especially during the era of equity.

IF Dr. Gatling were alive today I wonder what he would think about the Vulcan—noting the press and other publicity of 1956?

Today Dr. Gatling stands in the record book of ordnance as an "uncommon man." In conclusion, I submit he was! May we all go and with patience imitate his example.

Maj. Gen. Charles M. Wesson

In Memoriam

MAJ. GEN. Charles Macon Wesson, Chief of Ordnance of the Army from 1938 to 1942 and director of the vast Army weapons program of the United States until six months after Pearl Harbor, died at Walter Reed Hospital on November 24, 1956. He had retired from active duty May 31, 1942.

For his service in the First World War he was awarded the Distinguished Service Medal. He won an oak leaf cluster to the D.S.M. for his World War II service, with the following citation: "Major General Wesson was charged with the expansion of the Ordnance Department and the conduct of the greatest ordnance program of all time. In this position General Wesson demonstrated rare technical knowledge, drive, and good judgment and handled the work of the Department with such skill and boldness as to contribute greatly to the success of not only the war efforts of the United States but those of the United Nations."

General Wesson was recalled to active duty on June 1, 1942, for service with the Lend-Lease Administration. For his outstanding service during this period of his career, he was awarded the second oak leaf cluster to his D.S.M.

General Wesson was born in St. Louis, Mo., July 23, 1878. He was graduated from the United States Military Academy, West Point, a member of the Class of 1900.

First as an officer of the Cavalry and later of the Ordnance Department, he won recognition as an aggressive leader. He entered the Ordnance Department in 1907. Subsequently he was an instructor at West Point. For seven years he was on the staff and later became commanding officer of Watertown Arsenal, Watertown, Mass.

General Wesson served in France during the First World War, where he was in charge of construction and maintenance of ordnance for the A.E.F. and commanding officer of the ordnance repair shops at Mehun-sur-Yevre.

Following graduation from the Army War College in 1925, General Wesson was assigned to command the Aberdeen Proving Ground where he was instrumental in bringing that famous technical establishment to its world-renowned prominence. Later he was assistant military attaché at the U. S. Embassy, London, England. At the time of his appointment to be Chief of Army Ordnance in 1938, he was completing a second tour of duty as commander at Aberdeen.

The gathering European war clouds in 1938 witnessed the beginning of the largest arms-production program in the history of the United States. General Wesson directed the Army phase of this program, utilizing the research and production facilities of American industry to maximum effect.

For this, in addition to the oak leaf cluster to his D.S.M., he was awarded the Maj. Gen C. C. Williams Gold Medal of the American Ordnance Association at a testimonial dinner given by the Association at the Waldorf-Astoria, New York City, on May 28, 1942. The dinner was attended by leaders of the armed forces and American industry.

ON this occasion tributes to his leadership were paid by Bernard M. Baruch, World War I Chairman of the War Industries Board; Robert P. Patterson, Under Secretary of War; Lieut. Gen. William P. Knudsen, director of production; and General Wesson's successor as Army Ordnance Chief, Lieut. Gen. Levin H. Campbell, Jr.

Henry L. Stimson, Secretary of War, paid tribute to General Wesson at this testimonial dinner in these words: "To you fell the responsibility of directing our tremendous wartime ordnance program, a program unequaled in size by anything in our history. From a small organization in 1938 when you became Chief of Ordnance, you have built the splendid machinery capable of handling our program of tens of billions of dollars of ordnance matériel."

General Wesson maintained a great personal interest in the affairs of Army Ordnance and the American Ordnance Association to the last. The Association was the recipient of his counsel and active coöperation throughout his entire military career and in his retirement. His passing is deeply mourned by his wide circle of friends and admirers in the Ordnance Association and the Army.

For Air Defense

The Navy's new air-to-air guided missile, Sidewinder, above, and the pressure-suited pilot make a strong air-defense team. Sidewinder is a rugged, reliable, inexpensive weapon effective against bombers or fighters up to 50,000 feet (Navy photo).

Defense Highlights: Monthly Review and Outlook

• **Four seminars on new technological developments** in American armament were conducted at the annual A.O.A. Industrial Preparedness meeting at the Waldorf-Astoria in New York, December 5, 1956.

Each seminar consisted of presentations by experts from industry and the armed forces on phases of armament technology which are currently demanding intense research and application.

The first seminar—"New Developments in Metallurgy"—was presided over by Dr. R. F. Mehl, director, metals research laboratory, Carnegie Institute of Technology, Pittsburgh. He was assisted by Col. Benjamin S. Mesick, manager, Arthur D. Little Inc., Los Angeles; Comdr. Frank G. Scarborough, Bureau of Ships, United States Navy; and Dr. J. B. Johnson, chief scientist, aëronautical research laboratory, Wright-Patterson Air Force Base, Dayton, Ohio.

The second seminar—"New Developments in Electronics"—was presided over by Daniel E. Noble, vice-president, Motorola, Inc., Chicago, and chairman of the Guidance and Control Committee, Guided Missile and Rocket Division, American Ordnance Association. He was assisted by Rear Adm. Rawson Bennett, Chief of Naval Research, United States Navy; Dr. W. J. Pietenpol, director of development, solid state devices, Bell Telephone Laboratories, Inc., Murray Hill, N. J.; Col. Richard J. Meyer, chief of the Research and Development Division, Office, Chief Signal Officer, United States Army; and Col. Gordon Gould, Jr., chief, Communications and Electronics Division, Air Research and Development Command, Baltimore, Md.

The third seminar—"New Developments in Instrumentation"—was presided over by Ralph L. Goetzenberger, vice-president, Minneapolis-Honeywell Regulator Company, Washington, D. C., and chairman of the A.O.A. Fire Control Instrument Division. He was assisted by Col. Bernard R. Luczak, chief, Integrated Range Mission, White Sands Proving Ground, N. Mex.; Capt. W. R. Hunnicutt, U.S.N., Research and Development Division, Bureau of Ordnance, United States Navy; and Col. Richard Gibson, Headquarters, Air Development Center, Holloman Air Force Base, N. Mex.

The fourth seminar—"New Developments in Propulsion"—was presided over by Charles W. Guy, assistant manager, propulsion center, Rocketdyne division of North American Aviation Inc., Los Angeles, and chairman of the Propulsion Committee, A.O.A. Guided Missile and Rocket Division. He was assisted by Col. Miles B. Chatfield, Research and Development Division, Redstone Arsenal, Huntsville, Ala.; Comdr. Howard H. Montgomery, Propulsion Branch, Research and Development Division, Bureau of Ordnance, United States Navy; and Col. Paul Nay, chief, Aëronautics and Propulsion Division, Air Research and Development Command, Baltimore.

Louis Polk, vice-president of the Association in charge of Technical Divisions and Committees, was chairman of the morning program. He is president of the Sheffield Corporation, Dayton, Ohio. The afternoon program was presided over by Robert L. Biggers, Association vice-president for Posts and Chapters. Mr. Biggers is president of the Fargo Division, Chrysler Corporation, Detroit, Mich.

All texts will be published in succeeding issues of ORDNANCE.

• **The Rôles and Missions Memorandum** issued by Secretary of Defense Charles E. Wilson has two main areas of effect—Army aviation and intercontinental ballistic missiles. Both are fields of most serious import; instant readiness in both is essential. It would seem that policy will be fluid to meet constantly changing demands brought about by technological advances.

In matters affecting the use of aircraft by the Army, the combat zone is defined as extending not more than one hundred miles forward of the general line of contact between American and enemy ground forces. Its extension to the rear of the general line of contact will be designated by the appropriate field commander, and normally extends back of the front lines about 100 miles.

The Army aviation program will consist of those types of aircraft required to carry out the following Army functions envisaged within the combat zone: (1) Command, liaison, and communications; (2) Observation, visual and photographic reconnaissance, fire adjustment, and topographical survey; (3) Airlift of Army personnel and matériel; and (4) Aëromedical evacuation.

The Army aviation program will *not* provide for aircraft to perform the following functions: (1) Strategic and tactical airlift, (2) Tactical reconnaissance, (3) Interdiction of the battlefield, (4) Close combat air support.

• **The following new guide lines** for intercontinental ballistic missiles have been established in the Secretary's new policy statement:

1. The Army is assigned responsibility for the development, procurement, and manning of land-based surface-to-air missile systems for point defense (specified geographical areas, cities, and vital installations). Currently, missile systems in the point-defense category are the Nike, Nike B (Hercules), and land-based Talos.

2. The Air Force is assigned responsibility for the development, procurement, and manning of land-based surface-

to-air missile systems for area defense. Currently, the missile system in the area-defense category is the Bomarc.

3. The Navy, in close coördination with the Army and Air Force, is assigned responsibility for the development, procurement, and employment of ship-based air-defense weapon systems for the accomplishment of its assigned functions.

4. The Marine Corps is authorized to adapt to its organic use such surface-to-air weapons systems developed by the other services as may be required for the accomplishment of its assigned functions.

• **Mr. Wilson** declared that no basic changes in the present rôles and missions of the armed services were necessary but the development of new weapons and of new strategic concepts, together with the nine years' operating experience by the Department of Defense, pointed up the need for some clarification and clearer interpretation of rôles and missions.

"We have recognized the need for a review of these matters," he said, "and from time to time certain steps have been taken and we are now taking others to improve the effectiveness of our over-all military establishment, to avoid unnecessary duplication of activities and functions, and to utilize most effectively the funds made available by the people through Congress."

Mr. Wilson pointed out that clarification and interpretation of rôles and missions does not in itself predetermine the weapons to be used by each of the armed services and their numbers, nor the numbers of men to be trained in various fields.

"It should be clearly understood," he said, "that the approval of rôles and missions of the armed services for guidance in peacetime does not predetermine the weapons or forces which a commander in the field would be permitted to use in the event of war. Also, the development of a weapon by a particular military department does not in itself predetermine its use. Such determinations rest with the Secretary of Defense after considering the recommendations of the Joint Chiefs of Staff and the Secretaries of the military departments."

• **The United States is neglecting its talented youth,** according to Rear Adm. H. G. Rickover, chief of the naval reactors branch of the Atomic Energy Commission. He proposed that industry and labor, together with educational foundations, set up a series of twenty-five free secondary academic schools for the education of talented youths "now being miseducated by lock-step methods in the Nation's secondary schools.

"Our schools," Admiral Rickover said, "do not perform their primary purpose, which is to train the Nation's brain power to the highest potential. We shall not do justice to our talented youth until we seek them out at an early age—no later than 10 or 11—and educate them separately from the rest of the children. This should be done preferably in separate schools or if this is not possible in separate classes."

The new talent schools would be on a par with the best academic high schools. The only requirement for entrance would be the ability to pass an examination designed to weed out the unfit.

• **In this place** in our last issue an erroneous statement was published regarding chemical warfare. In alluding to the excellent work being done by the Army Chemical Corps and notably the Chemical Warfare Laboratory at Edgewood Arsenal, the statement was made that "Chemical warfare has been outlawed by treaty . . ."

We have been gently and properly reminded that this is an error in so far as the United States goes. Our informant is Lieut. Col. O. E. Roberts, Jr., secretary-treasurer of the Armed Forces Chemical Association. He writes:

"Any inference that the United States of America is restrained or barred by any treaty from the use of 'chemical warfare' is unjustified by the facts. Field Manual 27-10, Department of the Army 'Rules of Land Warfare,' page 29, headed 'Gases & Chemicals' states that the United States is not a party to any treaty now in force that prohibits or restricts the use in warfare of toxic or nontoxic gases or of smokes or incendiary materials, etc."

• **With airborne landings** having been made by our allies in the Far East, and the rôles and missions of the services being spelled out more distinctly than before, many eyes have been turned on the Army's reactivated 101st Airborne Division. Great things are expected of this division as the forerunner of a new extremely mobile type of major Army unit. Although still dependent upon outside airlift, it contains its own reconnaissance aircraft and helicopters for intrazone operations. It contains unusually high firepower in new light weapons, all of which are air-transportable, and it is organized around five combat groups instead of the usual triangular divisional arrangement of the past.

Early reports indicate that each combat group will be logistically self-sufficient for longer periods than present units of the same size. They will have good offensive punch but will still need the backing of heavy armor.

On the other hand, there are many who are concerned that the new outline of rôles and missions may restrict the efficiency of airborne divisions. It is hoped that sensible interpretation of this new directive will allow the Army to go ahead full steam in developing a modern fighting unit prepared to survive and fight battles in this atomic age.

• **The Air Force** is rushing completion of a giant concrete test stand in the Mojave Desert in California which will provide the means to test rocket engines and missile components having up to one million pounds of thrust. Anchored some 60 feet in solid rock, with an over-all length of 200 feet, the stand is designed like a reënforced-concrete bridge. Over 26,000 cubic yards of concrete are being used in the structure. It includes a 54-foot concrete cantilever, 15 feet at the outer end and 40 feet thick at the haunch. This cantilever is approximately 150 feet over a flame-deflector pit which will lead the gases from the test vehicles away from the stand.

The Peaceful Power of Strength

An Editorial

THE effectiveness of the time-honored position of the American Ordnance Association is again being demonstrated—that national peace is a direct function of national strength. The difficult state of affairs in the Near East provides the occasion for this comment.

The A.O.A. position was well described by former Under Secretary of the Army John Slezak, speaking at a meeting of the Association's Chicago Post. Mr. Slezak is a former director and a member of the Association's advisory board. He is a national leader with long experience in industry, and he achieved a superb record as a colonel of Ordnance and as chief of the Chicago Ordnance District in World War II.

"The terrifying effects of nuclear weapons," Mr. Slezak said, "bring to us very dramatically the urgent need to find a way to solve our difficulties by other means than force. Willy-nilly we live on the same planet, and that same planet has shrunk in size so much that it is increasingly more difficult to destroy our enemies without at the same time at least partly destroying ourselves. There must be a better way!

"Perhaps the time has come that we may properly change our famous slogan 'peace through strength' to 'peace through strength and understanding.' In the long run, the understanding of ourselves and of others may well succeed where the rule of 'might makes right' has failed. . .

"However," Colonel Slezak continued, "regardless of the loose statements that the next war, if it comes, will be over in a matter of days and that only the weapons on hand at the beginning of the war will be of any consequence to us, our strength does not lie in huge stocks of weapons and guns that deteriorate and grow obsolete, but our strength lies in the ability of our people to create and to produce. In other words, our strength lies in our ability as a nation to convert our total national resources into military strength quickly and effectively.

"This has been the basic philosophy of the American Ordnance Association since its very inception, and the tremendous effect that this attitude has had on the safety and security of our country is incalculable."

Peace through strength may eventually lead, as Colonel Slezak suggests, to peace through strength and understanding. We devoutly hope so. But strength is today's imperative. All of us are fully aware of the fact that strength is not needed when mutual respect and fraternal good will characterize international relations. This day should be hastened, as far as lies in our power and by every means in our power.

That such a day has not yet arrived, despite our earnest efforts, leaves us no recourse but to maintain our strength against all hazardous international contingencies.

Strength, however, is a 2-edged sword—it can protect the liberty of free men, but it can also be an instrument in the subversion of that liberty.

By this we mean that strength of its very nature creates a climate and atmosphere of complacency and well-being. We are secure. We have nothing to fear. We can enjoy the good things of life behind an impenetrable barricade.

The danger is that we can become so dedicated to the cause of peace that we will accept peace on any terms and at any price. Such an attitude would inevitably lead to the subversion of all moral values by which men live decent and fruitful lives.

Perhaps these thoughts were in the mind of Adm. Arthur W. Radford, Chairman of the Joint Chiefs of Staff, who declared on several occasions that the efforts of the United States to maintain military and moral strength were inseparable from efforts to live in secure freedom.

To live in freedom, he emphasized, is more important than peace. Not all wars are bad and not all peace is good, he added. Great men of history, he recalled, valued freedom "more than peace or wealth or life itself."

Admiral Radford's remarks were believed to reflect a widely held view that too many citizens had gained the impression that their leaders sought peace at any price.

Describing himself as a student of war and peace, Admiral Radford stressed the fact that no one detested war more than he and the 2,800,000 men and women in uniform he represented. But in talking on the subject of war and peace, he asserted that "we sometimes like to paint one all black and the other all white."

Noting occasions when war had developed teamwork and greatness of spirit among nations, Admiral Radford remarked that "peace has sometimes been the triumphant handiwork of deception, chicanery, and expediency over that which is morally right." He cited the Munich agreement and the bitter struggle of the Hungarian people as an example of the generations of hate and brutal oppression that stemmed from the loss of freedom.

"Surely this means something," he continued. "To me, it means that there are greater considerations in this world than the presence or absence of war. By greater considerations I mean the hopes and aspirations of people. I mean the ideals of individual liberty and spiritual values under God."

ALTHOUGH peace is not the supreme moral value in life, the major consideration is that strength is necessary to safeguard peace and, if war should be thrust upon us because of our defense of moral values, then strength will be needed to restore a just peace.

The position of the American Ordnance Association is founded on the hard rock of experience. Once again in these troubled days the philosophy of the peaceful power of strength has been demonstrated to be a wise and effective one. May we persevere in this philosophy for years without end!

ASSOCIATION AFFAIRS

Southern Chapter Inaugurated with Navy Demonstration at San Diego

At San Diego a new Chapter of the Association was inaugurated formally on October 17th at a 2-day meeting that was outstanding in A.O.A. annals. Over 450 members journeyed by train from the Los Angeles area to join with their compatriots in San Diego to initiate the Southern Chapter in a never-to-be-forgotten program.

The U. S. Navy was principal host for the occasion, ably seconded by Convair. Excellent bus arrangements whisked the crowd from one exciting event to the other. A tour of the North Island Naval Air Station and a "scramble" of Navy jet fighters was the first event. Next, on a sunny beach along the Silver Strand, a complete Naval amphibious landing was presented by Rear Adm. F. C. Stelter, Jr., and his Amphibious Training Command, Pacific Fleet.

From special stands on the beach all hands saw the underwater demolition team prepare the way by blowing up obstacles and countermining, followed by wave after wave of landing craft that disgorged 350 Marines who had been embarked in the attack transport SEMINOLE. They hit the beach yelling and firing all their smaller combat weapons.

Realism was added to the exercise when salvage boats dashed in to help retract some landing craft stuck in the soft sand. Simultaneously a division of twelve helicopters landed other Marines on the flank with amazing alacrity.

All were happy to dash to the quaint Hotel del Coronado for luncheon to fortify themselves for a visit with the Convair Division of General Dynamics Corporation in the afternoon. At Convair's vast Plant No. 2, B. F. Coggan, the general manager, greeted the crowd. Here the Air Force F-102 was in full production, and it was possible to observe the thousands of steps necessary to assemble the components and then the major parts to turn out a complete fighting machine.

The tight schedule allowed only a few minutes to freshen up at the barracks before assembly at the Admiral Kidd Club, Naval Training Center, for the reception and dinner meeting. The crowd had now swelled to more than 650. Distinguished representatives of all the rapidly growing airframe and electronics industries that contribute heavily to missile production were on hand to greet the members and the naval commanders present from the Pacific Fleet.

R. C. Geffs, Clary Corporation, president of the Los Angeles Post, as toastmaster introduced guests at the speakers' table and also many of the members who had labored so faithfully to establish the new San Diego Chapter. With proper ceremony, the Chapter was formally inaugurated, and its first chairman, Herbert Kunzel, president of Solar Aircraft Company, was presented with the charter.

Praise and heartfelt thanks were given the Navy for its generous coöperation to which Rear Adm. C. C. Hartman, commander of the 11th Naval District, replied. Admiral Hartman then introduced Vice Adm. A. M. Pride, Commander, Air Forces, Pacific Fleet, the guest of honor and principal speaker.

Admiral Pride spoke most interestingly of the Far East situation, the present status of each country that borders on the Eastern Pacific, and its future. He emphasized that it was principally the power and flexibility of the Seventh Fleet that enabled the United States to checkmate Communist advances.

At the speakers' table were: Hon. Thomas S. Gates, Jr., Under Secretary of the Navy; Admiral Pride; Admiral Hartman; Maj. Gen. Thomas A. Wornham, commanding general, Marine Corps Recruit Depot; Capt. Cecil T. Caufield, U.S.N., commander, Naval Training Center; Capt. Paul Foley, Jr., U.S.N., chief of staff, commander, Second Fleet; Capt. John E. Lee, U.S.N., commander, Submarine Flotilla One; Capt. H. L. Reiter, U.S.N.; D. B. Acker, vice-chairman, San Diego Chapter; and E. T. Austin, secretary, San Diego Chapter.

Also at the table were: Alexander Black, Solar Aircraft Company; Mr. Coggan, Convair; Mayor Charles Dail of San Diego; F. W. Fink, Ryan Aëronautical Company; C. J. Frandell, treasurer, San Diego Chapter; Mr. Geffs; Herbert Kunzel; H. M. Palmtag, Solar Aircraft Company, chairman, Chapter membership committee; J. E. Rheim, Rohr Aircraft Corporation; F. H. Rohr, Rohr Aircraft Corporation; and T. Claude Ryan, Ryan Aëronautical Company.

After the dinner few men lingered at the club, as they had arisen at three or four a.m., but retired directly to their double-deck bunks at the recruit barracks in preparation for an early reveille. Six a.m. came too soon, but a hearty Navy breakfast brightened up the crowd for its boat trip to the carrier HORNET, host ship for the day's firing demonstrations. On board they were welcomed by the skipper, Capt. W. W. Hollister, and greeted by Rear Adm. A. P. Storrs, III, commander of Carrier Division 5 and in command of the Exercise Task Unit.

At sea in the operating area the two live targets, obsolete infantry landing ships, were strafed, rocketed, and napalmed by aircraft launched from the

Rear Adm. A. P. Storrs, III, left, accepts check for Navy Relief Society from R. C. Geffs, president of the Los Angeles Post.

Hon. Thomas S. Gates, Jr., Under Secretary of the Navy, right, addresses dinner meeting of the new Southern Chapter of A.O.A.

A.O.A. members, above, line the deck of the aircraft carrier HORNET to watch demonstration of naval firepower. Below, Marines stage an amphibious landing for the A.O.A. at the U. S. Naval Amphibious Base at Coronado, Calif.

Below, members of the newly inaugurated Southern Chapter of the Los Angeles Post gather at North Island Naval Air Station to inspect the facilities and aircraft and to watch a "scramble" maneuver of fast Navy jet fighter planes.

The newly elected Chapter officers, below, discuss future plans. Left to right are: H. M. Palmtag, membership committee; C. J. Frandell, treasurer; Herbert Kunzel, chairman; D. B. Acker, vice-chairman; and E. T. Austin, secretary of the Chapter.

carrier SHANGRI-LA. The sturdy craft resisted these attacks but were sunk by the blazing 5"/38 main-battery guns of eight destroyers led by Destroyer Division 32—a thrilling spectacle for the assembled Ordnance fraternity.

Throughout this enjoyable day at sea every opportunity was afforded by the hospitable crew in HORNET for the guests to see the aircraft and the complex gear required in a combatant carrier. Coffee was always at hand, and the Navy chow at lunch was excellent. Never has an American Ordnance crowd been treated more royally.

During the day Mr. Geffs presented a donation to Admiral Storrs for transmittal to the Navy Relief Society. The check for $300 represented the excess of receipts over expenditures for the meeting.

Strongly supported by Bob Geffs, Los Angeles Post president, and assisted by many other Chapter members, the San Diego Chapter has launched into A.O.A. affairs in a memorable fashion, and the entire Association wishes it every success.

Meeting of the Bomb and Artillery Ammunition Division Is Held at White Oak, Md.

The annual meeting of the Bomb and Artillery Ammunition Division of the American Ordnance Association was held at the Naval Ordnance Laboratory, White Oak, Md., on October 5, 1956. This date being the day following the A.O.A. Annual Meeting at the Aberdeen Proving Ground, an excellent attendance was present.

The presiding officer throughout the meeting was Robert L. Telford, Division chairman and vice-president and executive officer of Mason & Hanger-Silas Mason Company, New York, N. Y. Comdr. William W. Wilbourne, commander of the Naval Ordnance Laboratory, opened the morning session with a warm word of welcome.

The following technical papers were presented: "Objectives of the Bomb Committee," by Brig. Gen. Merle H. Davis, engineering and production consultant, Franklin, Vt., secretary of the Bomb Committee.

"Late Developments in the Cartridge Case Field," by Lieut. Col. Leigh W. Worthing, Ordnance Ammunition Command, Joliet, Ill.

"Current Research and Development Projects in Packaging of Bomb and Ammunition Items," by Harvey C. Simms, Cleveland Container Company, Washington, D. C., chairman, Container Committee.

"Trend in Fuze Designs," by James E.

Burke, vice-president, Stewart-Warner Corporation, Chicago, Ill., and chairman of the Fuze Committee.

"Use of Method Study in Maintenance Work," by Harold S. van Buren, Procter & Gamble Company, Cincinnati, cochairman of the Loading Committee.

"The Future of Military Pyrotechnics," by Dr. Herbert Ellern, director, research and development, Universal Match Corporation, Ferguson, Mo., chairman of the Military Pyrotechnics Committee.

"Activities and Future Plans of the Shell Committee," by Walter N. Howley, president, Lansdowne Steel & Iron Company, chairman of the Shell Committee.

Following a delicious luncheon served in the headquarters building, the members of the Bomb and Artillery Ammunition Division spent an interesting afternoon on specially conducted tours of the laboratory.

• **AT TROY, N. Y.**—The fall meeting of the Capital Cities Post was held at the Troy Country Club on Tuesday, October 23rd.

The presiding officer, Prof. A. A. K. Booth, Post president, from Rensselaer Polytechnic Institute, opened the meeting with a brief business session. The guest speaker was Dr. Lindon E. Saline, manager of the regional General Electric engineering services. Dr. Saline discussed the public responsibility for manpower resources. He outlined the steps that could be undertaken by private and governmental organizations to increase the supply of engineers and scientists.

Prior to the meeting an open house was held at R.P.I. that enabled the members and guests to observe demonstrations in the science, engineering, and architecture departments at the institute.

• **AT CHAMBERSBURG, PA.**—More than thirty members gathered at the Officers' Club at the Letterkenny Ordnance Depot on Tuesday, October 23rd, to plan the organization of a Cumberland Valley Chapter.

William Strauss presided at the meeting which also was addressed by Col. Frederick G. Waite, commanding officer, Letterkenny Ordnance Depot; Albert P. Schwarz, the instigator of the idea of forming a Chapter in this area; Brig. Gen. R. W. Daniels, U.S.N., Ret.; and Capt. J. M. P. Wright, staff consultant, national A.O.A. headquarters.

It is expected that a membership of eighty to ninety members will rally to this new Chapter at the inaugural meeting which is planned for the middle of January. Prior to that time the members will be balloted to elect officers.

• **AT BEDFORD, MASS.**—The Yankee Post held its fall meeting at Hanscomb Air Force Base on Wednesday, October 24th. A large turnout of members assembled at the gate promptly at 4:00 p.m. from where they were conducted on inspection of some of the equipment of the Cambridge Air Force Research Center. This included a C-121 equipped as an airborne radar station, the new F-102A delta wing fighter built by Convair, and the trusty F-86 Sabrejets in their hangars on round-the-clock readiness under the Continental Air Defense Command.

After the reception and dinner, a brief business meeting was conducted by Post president M. Edgar Fain followed by a welcome from Maj. Gen. William M. Morgan, Hanscomb Air Force Base commander.

The principal speaker of the evening was Col. Dorr E. Newton, Jr., deputy commander, who described the research and development problems in connection with developing a weapons system. An explanatory talk and film were presented by Dr. V. Alexander Nedzel of the Research Center to show the operations of SAGE, the Semiautomatic Ground Environment Air Defense System for the United States.

It was a most worth-while meeting and gave all the members new insight into the effectiveness of the air defense of this country.

General McAlister Addresses Meeting of Lone Star Post at Dallas, Tex.

A.O.A. members of Northern Texas who form the Lone Star Post gathered in full strength at Dallas for their fall meeting at the Statler-Hilton Hotel on September 14th.

After the invocation by the Rev. I. O. Woodall, the new officers and directors were introduced by I. Nevin Palley, vice-president, Temco Aircraft Corporation, the outgoing president.

Maj. Gen. F. M. McAlister, U.S.M.C.

The newly elected president, R. C. Blaylock, vice-president of Chance Vought Aircraft Company, assumed the chair and introduced A. B. Thompson who delivered the preamble to the A.O.A. constitution.

Following his introduction by Mr. Blaylock, Maj. Gen. F. M. McAlister, U.S.M.C., Assistant Chief of Staff, Logistics, Marine Corps Headquarters, Washington, D. C., the guest of honor, gave a splendid report on the new weapons and equipment of the Marine Corps, the reasons for their design, and the manner in which they are employed. The general received a tremendous ovation, and the meeting was judged to be the most successful ever held by the Lone Star Post.

The new officers and directors in addition to Mr. Blaylock are: L. A. Childs, Jr., Temco Aircraft Corporation, Dallas, first vice-president; R. H. Norris, Dearborn Stove Company, Dallas, second vice-president; A. B. Thompson, Chance Vought Aircraft Company, Dallas, secretary-treasurer; H. R. Jordan, Chance Vought Aircraft Company, Dallas, national Council representative; and the following directors: H. F. Haslbauer, Dallas; F. L. Lebus, Jr., Longview; W. W. Wells, Fort Worth; Forbes Mann, Dallas; F. W. Davis, Fort Worth; A. M. Kahan, College Station; I. N. Palley, Dallas; F. B. McKimball, Dallas; Homer Dunn, Sherman; W. B. Freeman, Dallas; G. H. Brown, Wichita Falls; W. F. Joyce, Dallas; E. A. Malick, McGregor; and Maj. Earl M. Campbell, Dallas.

Puget Sound Post Holds Two-Day Meeting with the Navy at Bremerton, Wash.

The Puget Sound Post members were guests of the Navy in a fascinating 2-day outing August 17th and 18th. The party from Seattle headed by Col. Marmion Mills, Post president, arrived at the Bremerton Navy Yard in the early afternoon of the 17th and were greeted by Capt. W. T. Jenkins, U.S.N., assistant to the commandant of the 13th Naval District for naval base matters. The captain, a long-time A.O.A. member and Navy ordnance expert, briefed the guests on details of the visit.

A tour of the shops of the shipyard,

Capt. D. J. Donaho, U.S.N.

one of the largest in the country, was followed by a reception and dinner at the commissioned officers' mess.

After the dinner meeting members adjourned to the auditorium where the guest of honor, Capt. D. J. Donaho, U.S.N., described operations and armament of the Navy's air squadrons. Captain Donaho, commander of the Naval Air Missile Test Center, Point Mugu, Calif., who is specially well informed on naval air ordnance, gave an excellent and informative talk on the Navy's air-power potential.

The captain's talk helped greatly to make the members feel more at home the next day on the cruise aboard the HORNET. Those members able to make the trip were accommodated on board overnight and were up early to witness underway preparations.

After clearing the shipyard, all hands of the Puget Sound Post were welcomed by the ship's officers who guided them in an inspection tour of the HORNET, especially its armament and ordnance.

As this was a preliminary shakedown trip, the commanding officer, Capt. N. A. Campbell, conducted drills and exercises also witnessed by the A.O.A. party.

Upon arrival at the Naval Ammunition Depot at Bangor the members disembarked and returned by bus to Bremerton.

Redstone Arsenal Is Host To Huntsville Chapter of the Birmingham Post

The Huntsville Chapter of the Birmingham Post with a membership of over 150 held its first meeting of the season on November 16, 1956. The well-planned program comprised an afternoon meeting at the Rocket Development Center at Redstone Arsenal and a dinner meeting at the Robert Erskine Hotel in Huntsville.

The topic of the afternoon meeting was new naval weapons. Comdr. Nathan Sonenshein of the Navy Bureau of Ships described proposed ships of the future. Capt. William E. Sweeney, U.S.N., director of the Avionics Division of the Navy Bureau of Aëronautics, discussed new aircraft and showed a thrilling film of carrier landings on the FORRESTAL.

Capt. Robert W. McNitt, U.S.N., Research and Development Division, Navy Bureau of Ordnance, in his talk utilized an interesting film showing comparative effectiveness of the old and the very latest naval weapons.

To further enhance the appreciation of new weapons there were models on display in the auditorium including a full-scale Terrier, the carrier FORRESTAL, and some of the latest naval aircraft.

At the dinner meeting at which J. A. Muller, Chapter chairman, presided there was a brief business session followed by a welcome to the Navy. The guest speaker was Capt. Grayson Merrill, U.S.N., technical director in the Special Project Office of the Navy Bureau of Ordnance, who gave a most interesting talk comparing the utilization and relative effectiveness of guided missiles and aircraft in expected modern conditions of warfare.

Engine and Power Train Committee Holds First Meeting in Detroit

The following members of American industry under the chairmanship of Errol J. Gay, an engine consultant in Detroit, assembled at the Detroit Athletic Club at 9:30 a.m. on October 25, 1956, to hold the first meeting of the Engine and Power Train Committee of the Combat and Tactical Vehicle Division of the A.O.A.: J. W. Asselstine, engine specialist, Ford engineering staff; Carl Bachle, vice-president and chief engineer, Continental Aviation & Engineering Corporation; Robert J. Templin, staff engineer, Cadillac Motor Car Division, General Motors Corporation; Albert Beckman, representing Harold L. Welch, assistant chief engineer, Chrysler Corporation; and Robert R. Burkhalter, executive engineer, Dana Corporation. Max M. Roeusch, director of Chevrolet Engineering Laboratories, was unable to attend the meeting.

Also attending were the following from Army Ordnance: Col. William Call, program coördinator, Ordnance Tank Automotive Command; Col. Roger Hemion, chief of research and development, Ordnance Tank Automotive Command; Joseph B. Hayes, chief engineer, Ordnance Tank Automotive Command; E. F. Blackburne, chief, Automotive Components Branch, Ordnance Tank Automotive Command.

The main purpose of this meeting was to brief the Committee members of the present state of the engine and transmission programs, the new Army fuels policy, and to give them a look at the future needs of the Army for engines and transmissions.

Mr. Hayes, with the assistance of Mr. Blackburne, gave a thorough presentation of a possible future Army designed for maximum air transportability.

The Army's new fuel policy was outlined by Mr. Gay and further discussed by Mr. Blackburne. This policy requires maximum use of gasoline and estimates octane levels available up to 1960. It further states that compression-ignition engines may be used for combat and heavy equipment using a fuel similar to JP-4.

It suggests that it would be most desirable for compression-ignition engines also to possess the ability to operate satisfactorily on gasoline. It further requires that existing Diesel equipment be converted to use gasoline or the JP-4 type fuel.

The past few years have seen excellent progress by Ordnance in the development of efficient transmissions. There is now either available or in the prototype stages multispeed, lockup-type torque-converter transmissions to cover a wide range of Ordnance equipment.

The present line of Ordnance engines covers air-cooled engines for combat

equipment and liquid-cooled commercial or semicommercial engines for trucks and related equipment. All these engines are gasoline, spark-ignition engines.

There is under development, however, a compression-ignition engine (an air-cooled, V-type, supercharged Diesel). This engine is already in the multicylinder test stage and has shown excellent preliminary results as regards power output and fuel economy.

The engine uses a turbo-blower. It is expected that this basic engine can be modified by the use of different combustion process so that it can utilize gasoline, JP-4, and Diesel fuel.

Another engine program from a different source is about eighty per cent complete in the development of a compression-ignition engine of an "X" configuration that will also burn all three fuels. It will be at least two years before results on this engine are completed and evaluated.

The Committee will meet again next spring unless some emergency should arise that would warrant an earlier meeting.

Empire Post Members Hold Golf Tourney and Dinner Meeting at Syracuse, N. Y.

Association members poured in from all parts of Western New York State for the annual meeting of the Empire Post at Syracuse on September 25th.

Following an afternoon of golf in competition for the Empire Post Cup, members and guests assembled at the Hotel Syracuse for a reception and dinner meeting. Ralph F. Peo, Empire Post president and president of Houdaille Industries, Inc., Buffalo, presided, greeted the guests, and introduced Charles N. Howard of New Process Gear Corporation, the toastmaster.

Mr. Howard then introduced in turn the following distinguished guests at the head table, each of whom spoke briefly in praise of the outstanding work of the Ordnance Association and offered the continued support of the organization he represented:

Comdr. John A. Taylor, inspector of naval material, Syracuse Area; Joseph R. Shaw, Albany, president, Associated Industries of New York State; Col. William A. Davis, deputy chief, Rochester Ordnance District, secretary, Empire Post; Brig. Gen. Robert S. Israel, Jr., commander, 32nd Air Division; Kenneth A. Digney, president of Oberdorfer Foundries and president of the Manufacturers Association of Syracuse; Hon. Donald H. Mead, Mayor of Syracuse; Col. Alexander S. Young, commanding officer, Rochester Air Force Procurement District; and Brig. Gen. Tom C. Rives, U.S.A.F., Ret., technical consultant, General Electric Company, chairman of the Syracuse-Central New York Chapter.

Capt. J. M. P. Wright, from national A.O.A headquarters, greeted the members on behalf of the national officers and directors and presented a certificate of appreciation to Ray C. Malvin of Houdaille Industries for his loyal coöperation and support of the Association while president of the Empire Post, 1953-1955.

The guest of honor and principal speaker was Capt. Edwin B. Hooper, U.S.N., Assistant Chief for Research and Development, Navy Bureau of Ordnance, who delivered a most interesting address on "the new look in naval weapons."

The invocation and benediction were given by Maj. John E. Muldoon, Jr., chaplain, Combat Command B, 27th Armored Division, New York National Guard.

This was an outstanding meeting in the excellent arrangements and the skillful scheduling of the program. Credit was accorded eloquently by Mr. Peo to the hard-working committee who engineered this affair: General Chairman George R. Auld, Carrier Corporation; Vice-Chairman C. Earl Norquist, Norquist Products, Inc.; Fred Gangberg, General Electric Company; Charles M. Howard, New Process Gear Corporation; Harold B. Martin, Carrier Corporation; Daniel H. Robinson, Precision Casting Company; Edwin R. Tharp, Union Chemical and Materials Corporation; E. Gwyn Thomas, Manufacturers Association of Syracuse, Inc.; and John H. Walsh, Carrier Corporation.

Among distinguished guests at Empire Post meeting were, right to left: Col. W. A. Davis, Comdr. J. A. Taylor, J. R. Shaw, Capt. E. B. Hooper, U.S.N., Brig. Gen. R. S. Israel, Jr., Post President R. F. Peo, and Col. A. S. Young.

Ammunition Subcommittee Holds Inaugural Meeting at Chrysler Plant, Detroit

The first meeting of a special Ammunition Task Force Subcommittee of the Powder Metallurgy Committee, A.O.A. Advisory, Technical, and Research Group, was held on November 1, 1956, at the plant of the Chrysler Corporation in Detroit, Mich.

The membership of this Ammunition Task Force Subcommittee, consisting of one especially selected representative from each of the five Army Ordnance ammunition arsenals, is as follows: R. Ridgeway, Ordnance Ammunition Command, Joliet, Ill., chairman; W. A. Blittersdorf, Industrial Engineering Division, Frankford Arsenal, Philadelphia, Pa., secretary; Dr. B. L. Davis, Diamond Ordnance Fuze Laboratories, Washington, D. C.; F. W. Littleford, Lake City Arsenal, Independence, Mo.; and J. R. Michaud, Industrial Engineering Division, Picatinny Arsenal, Dover, N. J.

The Ordnance Ammunition Command at Joliet, Ill., it is believed, has taken a great forward stride in fostering the organization of this entirely new type of A.O.A. group.

Through their contacts with the industry members of the A.O.A. Powder Metallurgy Committee, inspections of industrial plants, A.O.A. Committee meetings, etc., these Subcommittee members from the arsenals will themselves gradually become more or less expert in the proper and effective utilization of powder metallurgy.

These individuals in turn will then be able to transmit their knowledge to the engineers and designers at their respective

offices—primarily before new designs are released for production. They will also be in a position to act promptly in securing additional information from American industry in case data beyond their knowledge of powder metallurgy are ever involved.

It is believed that this new type of A.O.A. Committee activity may become a pattern to be used by the other armed services where it may be desired to utilize new materials and methods of manufacture as they are developed by American industry.

General Cummings Speaks on Modern Weapons at Philadelphia Post Meeting

In Philadelphia the great hall of the Franklin Institute, dominated by its historic statue of Benjamin Franklin, was the scene on October 2, 1956, of an eventful meeting of the Philadelphia Post of the Association. Lieut. Gen. Emerson L. Cummings, Chief of Ordnance of the Army, was the honor guest and principal speaker. General Cummings spoke on "Trends in Modern Weapons" and gave a masterful portrayal of the effects of new technological developments of Army Ordnance.

E. B. Webster, vice-president, Crown Cork & Seal Company, who is president of the Philadelphia Post, presided at the meeting. Brig. Gen. Joseph M. Colby, commanding officer of Frankford Arsenal, introduced General Cummings.

The occasion was highlighted by the attendance of the Ordnance district chiefs and deputy chiefs, the arsenal commanders, and administrative personnel from the Office of the Chief of Ordnance who were in Philadelphia for their semiannual conference on policies and operations. These conferences have become a highly important part of Army Ordnance administration, bringing together the headquarters and field points of view of both the military and civilian personnel.

Other speakers at the dinner were Col. H. C. Thayer, deputy chief of the Philadelphia Ordnance District, and Col. Leo A. Codd, executive vice-president of the American Ordnance Association at Washington.

Others at the speakers' table in addition to those named above were: Maj. Gen. F. A. Hansen, chief of Field Service, Office, Chief of Army Ordnance; A. W. Gilmer, chief, Philadelphia District; Maj. Gen. N. M. Lynde, Jr., commanding general, Ordnance Tank-Automotive Command, Detroit; A. J. Seiler, vice-president, Philadelphia Post; H. P. Gant, vice-president, Philadelphia Post; Brig. Gen. T. A. Weyher, commanding general, Ordnance Weapons Command, Rock Island, Ill.

Also at the speakers' table were: Col. Wm. J. Adams, chief, Philadelphia Air Procurement District; R. D. Drake, secretary-treasurer, Philadelphia Post; Maj. Gen. R. G. Butler, commanding general, Ordnance Ammunition Command, Joliet, Ill.; Brig. Gen. J. E. Engler, chief, Industrial Division, Office, Chief of Ordnance; and the following directors of the Philadelphia Post: G. Burnham, D. H. Hauseman, E. J. Langham, H. F. Dever, J. G. Heckscher, F. O. Reedy, C. Jared Ingersoll, Henry N. Marsh, McClure Kelly, H. C. Knerr, J. H. Gillies, V. deP. Goubeau, William H. Worrilow, Sr., and R. H. Andrews.

Secretary Higgins and Procurement Panel Address the Cincinnati Post

Assistant Secretary of the Army for Logistics Frank H. Higgins and his panel of experts on Army procurement were the principal attraction of the annual gathering of the Ordnance fraternity in Cincinnati. This occasion was the setting for the Cincinnati Post Annual Meeting held on Tuesday, October 16th, at the Alms Hotel.

In the afternoon a procurement conference was held in the hotel ballroom at which over 600 industrialists and businessmen of the area listened to a complete exposition of Army procurement practices from the Secretary and his panel.

Panel members were: Maj. Gen. Henry R. Westphalinger, director of procurement, Office of the Deputy Chief of Staff for Logistics; Brig. Gen. Jean E. Engler, chief of the Industrial Division, Office, Chief of Ordnance; Col. Nicholas R. Voorhis, chief of the Procurement Law Division, Office of the Judge Advocate General; Lieut. Col. William W. Thybony, chief of the Procurement Division in the Office of the Assistant Secretary of the Army (Logistics); and Jack W. Askins, small-business adviser to the Assistant Secretary of the Army (Logistics) and to the Deputy Chief of Staff for Logistics.

Robert S. Gruver, Armco Steel Corporation, president of the Post, presided at the dinner assembly. After introduction of guests, Louis Polk, president, Sheffield Corporation and vice-president of the A.O.A., delivered the preamble to the A.O.A. constitution. This was followed by the presentation of a certificate of appreciation to John D. O'Brien, former president of the Post.

The big moment of the meeting was the presentation of the Charles L. Harrison Gold Medal to Secretary Higgins. The citation was read by Frederick V. Geier, Post director, and the award was presented by Harvey C. Knowles, vice-president, American Ordnance Association.

The Secretary replied in his genial and friendly manner and captivated his audience with the excellent points he made in behalf of the close cooperation of industry with the Army in order to further perfect the procurement programs.

Others seated at the speakers' table were: the Post officers and directors; members of the Army Procurement Panel; J. B. Doan, former Post president and chairman of the board, American Tool Works; Capt. Richard B. Levin, U.S.N., professor of naval science, Miami University, Oxford, Ohio; E. Webster Harrison, former Post director and treasurer and son of the late Charles L. Harrison; Hon. Henry N. Marsh, former Deputy Assistant Secretary of the Army (Logistics), now with Hercules Powder Company.

Also at the speakers' table were: E. A. Muller, former president and director of the Post; Lieut. Gen. E. L. Cummings, Chief of Army Ordnance, Washington, D. C.; Lieut. Gen. C. B. Magruder, Deputy Chief of Staff for Logistics, Department of the Army, Washington, D. C.; Gen. Benjamin W. Chidlaw, vice-president, Thompson Products, Inc.; and Walter W. Tangeman, former Post president and chairman of the board, Cincinnati Milling Machine Company.

New Orleans Post Receives Charter, Hears Address by Maj. Gen. E. P. Mechling

The recently established New Orleans Post held its annual dinner meeting at the St. Charles Hotel on October 17th to install its newly elected officers.

A splendid turnout of more than half the membership was on hand to greet the guest of honor, Maj. Gen. E. P. Mech-

ling, commander, Air Force Armament Center, Eglin Air Force Base, Fla. Members and guests were welcomed by W. L. Love of Rheem Manufacturing Company, outgoing president, who then introduced

Left to right: Brig. Gen. E. P. Mechling, W. L. Love, R. S. Murphy, and Mel Leavitt.

the new president, R. S. Murphy, Jr., of Higgins, Inc.

The constitution and by-laws of the Post were unanimously approved by the members. Mel Leavitt of Station WDSU in New Orleans was introduced as toastmaster and following a reading of the preamble of the A.O.A. constitution presented General Mechling to the meeting.

The general officially presented the New Orleans Post charter on behalf of the national president and directors of the A.O.A. He then described the operations at the Air Force Armament Center and the manner in which the center coöperates with industry in pursuing the development of new aircraft armament. General Mechling outlined the manner in which the A.O.A., particularly its Technical Committees, was of great assistance in furthering his programs.

Chicago Post Is Host to Secretary Higgins and His Procurement Panelists

The Annual Meeting of the Chicago Post was held at the Congress Hotel on Wednesday, November 7th. This occasion was taken to honor Assistant Secretary of the Army for Logistics Frank H. Higgins and to learn about the latest industrial procurement problems from the Secretary's panel of experts.

In the afternoon, more than 400 members of the A.O.A. and other associations assembled in the Gold Room for the panel seminar. Secretary Higgins introduced his panel: Maj. Gen. Henry R. Westphalinger, director of procurement, Office of the Deputy Chief of Staff for Logistics; Brig. Gen. Jean E. Engler, chief of the Industrial Division, Office of the Chief of Army Ordnance; Col. Nicholas R. Voorhis, chief of the Procurement Law Division, Office of the Judge Advocate General; Lieut. Col. William W. Thybony, chief, Procurement Division, Office, Assistant Secretary of the Army (Logistics); Jack W. Askins, small-business adviser to the Assistant Secretary of the Army (Logistics) and to the Deputy Chief of Staff for Logistics.

In the forum that followed, the panel members discussed the various forms of contracts and preaward matters, each phase being followed by interesting and provocative questions from the audience that were skillfully answered by panel members.

In the evening after a brief reception and dinner, Thomas Drever, president, American Steel Foundries, and Post president, called the meeting to order and introduced the Hon. John Slezak, former Under Secretary of the Army, as toastmaster.

Mr. Slezak presented his working philosophy for this era of uneasy peace. He pointed particularly to the excellence of the basic philosophy of the A.O.A. that assured the ability of this Nation to convert its total national resources into military strength through the close coöperation of industry and the armed forces.

Secretary Higgins, holder of the Cincinnati Post's Charles Harrison Gold Medal, 1956, was the guest of honor and principal speaker. In his talk he gave further meaning and depth to the Army's program for ensuring the most effective manner of conducting its procurement. He made it clear that the Army was leaving no stone unturned to assure the closest coöperation with industry in order to procure the best equipment for our soldiers.

Pittsburgh Post Members Make Inspection of Atomic Power Generating Station

Approximately two hundred members and guests of the Pittsburgh Post, wearing badges showing their name and company affiliation, journeyed by bus to the Allegheny Country Club, Sewickley

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Heights, for their annual meeting on October 18th.

W. K. Fitch, Post president, a national director of the American Ordnance Association and chairman of the Dravo Corporation, presided at the luncheon meeting. He welcomed the members and guests and reported that the Post had progressed considerably in the last year, with a present membership of 1,391 individual members and 88 company members.

Henry N. Marsh, of the Hercules Powder Company, a director of the American Ordnance Association, made a few remarks and conveyed the felicitations and salutations of national headquarters. Col. Ross R. Caldwell, chief of the Pittsburgh Ordnance District, reviewed the highlights of the Aberdeen Meeting on October 4th with particular emphasis on the effectiveness of the new equipment shown at the demonstration.

R. B. Donworth, vice-president of the Duquesne Light Company, who will operate the plant, described many of the details of the new Atomic Power Generating Station at Shippingport, Pa., which the Post members and their guests were to see later in the day.

Charles H. Weaver, vice-president of the Westinghouse Electric Corporation, which is furnishing the reactor and other equipment for the new power plant, stated that this was the first atomic power generating plant in the World with no other important by-product but power.

The district's key Army, Navy, Air Force, and Atomic Energy Commission personnel, and the directors of the Pittsburgh Post, who were seated at the speakers' table, were introduced. The meeting then adjourned to Shippingport, Pa., to the new atomic power generating station.

Each person was given a protective helmet, and, after careful accrediting, was ushered through the partially completed installation at Shippingport. The crowd was divided into small groups of ten persons led by a contractor's representative guide who explained details of the installation and answered questions as the tour progressed. After much climbing around through various tunnels, down and up stairways and catwalks, the group returned to their buses impressed with this, the first major atomic power generating station in the world.

The Shippingport plant is expected to be in operation next year and with 60,000 k.w. capacity will be the first generating plant able to furnish worth-while amounts of power for public consumption. A memorable feature of the visit was that the Pittsburgh members saw a great deal of the construction that soon will be buried forever from view.

Washington Post Holds Annual Golf Tourney and First Luncheon Meeting

The annual American Ordnance Association Golf Tournament was held under the auspices of the Washington Post at the Army-Navy Country Club on Thursday, October 18th. The largest turnout of golfers ever assembled for this event teed off throughout the day to compete for the A.O.A. trophies.

In the evening others joined the golfers to swell the number to 440 who participated in a gay evening of awarding the golf prizes and the drawing for door prizes which followed an informal supper.

The winner of the Benjamin F. Fairless Trophy inaugurated by the United States Steel Corporation was Fred Zoll, Jr., Libbey-Owens-Ford Glass Company, who had a low gross of 73. Charles H. Donelson, of P. R. Mallory & Company, won the McCaffrey Trophy established by the International Harvester Company, with a low net score of 67. There were many other prizes given for various achievements, such as the most birdies, low score on certain selected holes, and the usual booby prize for the highest score.

Although every member and guest was presented with a neat travel clock, there was great interest in the drawing for a number of door prizes including a television set, silver punch bowl, gift certificates, and two radios. There were golf clubs and other prizes for golf and horseshoe-pitching winners.

The day was voted a huge success by all hands. Special tribute was paid to the hard work of the many committees whose chairmen were: General Committee, Al Decker, Allis-Chalmers Manufacturing Company; Golf Committee, Robert Berry, Avco Manufacturing Company; Prize Committee, Kenneth Hampton, Detroit Diesel Engine Division, General Motors Corporation; Arrangements Committee, Mel Harris, Budd Company; Horseshoe Committee, Jim Clark, Bureau of Ordnance, United States Navy.

(*Continued on p. 636*)

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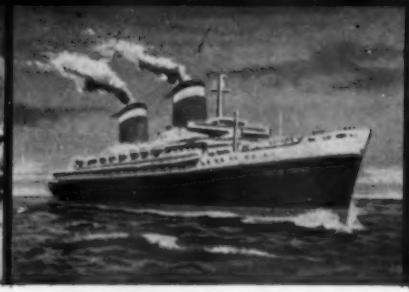

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The Post launched its season of monthly luncheon meetings at the Army-Navy Country Club on Thursday, November 15th. An excellent turnout of industrialists and servicemen attended the first session under the leadership of the new Post president, Franklin B. Reybold, Alco Products, Inc.

The many officers on hand from Army Ordnance were given a special greeting by the president.

Mr. Reybold first called on Capt. J. M. P. Wright of A.O.A. headquarters to present a certificate of appreciation on behalf of the A.O.A. national board of directors to George M. Riveire for his active and effective leadership as Washington Post president, 1954-1956.

The guest speaker, Dr. Albert G. Hill, director of research and development in the Weapons System Evaluation Group, outlined the mission of W.S.E.G. and described an imposing series of technical problems that face the Department of Defense.

Others at the head table were: Dr. C. A. Boyd, deputy director of research, W.S.E.G.; Maj. Gen. S. R. Browning, Deputy Chief of Transportation, U. S. Army; Lieut. Gen. E. L. Cummings, Chief of Ordnance, U. S. Army; Courtney Johnson, Deputy to the Assistant Secretary of the Army (Logistics); Brig. Gen. Clarence J. Hauck, Jr., Deputy Assistant Secretary for Legislative Affairs, Defense Department; and Col. Leo A. Codd, executive vice-president, American Ordnance Association.

Rocky Mountain Post Presents James D. Maitland with Medal Named in His Honor

Rocky Mountain Post members and their ladies assembled for their annual dinner meeting at the Cosmopolitan Hotel in Denver on Friday, November 16th.

Dr. Robert L. Stearns, president, Boetcher Foundation, as toastmaster greeted the members who also heard reports from Harold Silver, president of the Rocky Mountain Post, and F. H. Wadley, president of the Manufacturers Association of Colorado, cohosts for the evening.

After a gay interlude of old-time songs led by Mrs. Mary Dobbs Tuttle at the organ, the guest speaker, Maj. Gen. Russell L. Maxwell, vice-president, American Machine & Foundry Company, and past president of the New York Post, discussed "Atoms for Industry."

The general outlined the "Government-monopoly" period of atomic development and then described the growth of industrial applications since restrictions were lifted in 1954. His conclusions on the pitfalls and prospects for those who work with atoms were of great interest to the industrialists present.

General Maxwell is especially qualified in the field of industrial atomic energy through his duties with American Machine and Foundry Company. Here he has been in the forefront of atomic energy matters both while his company was a contractor to the Atomic Energy Commission and recently in the field of private reactor and food sterilization programs.

The final event was the inauguration and first presentation of the James Dreher Maitland Gold Medal, established this year by the Rocky Mountain Post in honor of the man who has been a leader in industry and A.O.A. affairs in the Denver area for many years. The first award of the medal was made, appropriately, to Mr. Maitland himself. The citation accompanying the medal reads:

"The members of the Rocky Mountain Post, American Ordnance Association, are firm in the belief that industrial preparedness for the national defense of the United States is an essential part of our national security. They are conscious that all of American industry in the Denver area shares in this grave responsibility. They wish to perpetuate this belief and implement it with continuing coöperation between American industry and the armed forces of our country.

"As a symbol of such coöperation, James Dreher Maitland of Denver stands preëminent in this area. A lifelong leader in all civic, industrial, and charitable causes, his service to our armed forces in the Second World War was outstanding. His company was a leading producer of artillery shells of superior quality and of low unit cost. He was a founder of the Rocky Mountain Post, has served as its president, and continues to give generously of his time and talents to armament preparedness of the United States.

"In recognition of Mr. Maitland's superb contribution to the security and peace of our country, the Rocky Mountain Post has established an annual award for distinguished Ordnance service—a a gold medal bearing his name—and gratefully presents the first such award to him with appreciation and affection."

This event will long be remembered in A.O.A. annals as it paid tribute to one of the most widely known and best-liked members of the A.O.A. Ever since World War II, Jim Maitland has been an ardent supporter of the Association.

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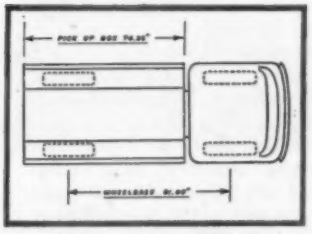

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• **AT ALBUQUERQUE.**—The monthly meeting of the Albuquerque Post was held on Monday evening, November 19, 1956, in the engineering auditorium of the University of New Mexico.

A small enthusiastic group assembled on the call to order of the Post president, Rear Adm. W. W. Juvenal of Lytle Engineering Company. After a brief business session, the admiral introduced Walter L. Tann, chief industrial engineer, Material Division, Navy Bureau of Ordnance.

Present at Albuquerque Post meeting were, left to right: C. W. Lytle, president, Lytle Engineering Company, W. L. Tann, and Rear Adm. W. W. Juvenal, Post president.

Mr. Tann described the manner in which the Bureau of Ordnance supports the fleet in peace and war. He also pointed to the importance of the close cooperation required of industry in order to ensure that the fleet receives its fighting equipment in perfect working order and on schedule.

Surface Preservation Group Holds Twentieth Meeting at Frankford Arsenal

The twentieth meeting of the A.O.A. Surface Preservation Committee of the Advisory, Technical and Research Group, was held at the Frankford Arsenal, Philadelphia, Pa., on October 3, 1956, with Dr. George W. Seagren, Mellon Institute of Industrial Research, Pittsburgh, Pa., presiding.

In opening the meeting, Chairman Seagren mentioned that the first meeting of the Surface Preservation Committee was held at Frankford Arsenal on October 11, 1949, and expressed appreciation for having the facilities made available again. The chairman introduced Colonel Kundel, chief of the Ammunition Group, who welcomed the members to Frankford Arsenal in behalf of the commanding officer, Brig. Gen. Joseph M. Colby.

Chairman Seagren then proceeded with the following technical program:

1. *Phosphate Coating Specification MIL-C-16232.*—The phosphate coatings specifications, MIL-C-16232 (A and B) and MIL-C-490A, were discussed to decide when and where they should be used and by what agency they are controlled. It was stated that these specifications are now being coördinated and that the progress being made should result in a report at the next meeting.

S. J. Barber referred to Sec. I, page 2 in MIL-C-16232A(N.Ord.) where it is stated that the solution shall be free from chlorides and asked that the limits be defined. J. J. Basch pointed out that the chloride content of water supplies must be taken into consideration in setting limits.

M. Roosa asked if performance specifications would be separate from chemical specifications for these coatings and was assured by H. F. Davidson that they would be separate.

Chairman Seagren suggested that representatives from Watertown Arsenal be present at the next meeting to discuss MIL-C-16232A.

Mr. Basch suggested that all members concerned write individually for a copy of this specification for study before the next meeting.

2. *Specification JAN-P-450 (paints, acid-proof, black, for ammunition).*—It was reported that the Navy will use TTP664 instead of JAN-P-450 on the interior (cavity liner) and exterior of projectiles if tests in progress for the past six months are successful six months hence.

H. L. Ammlung informed the group that acrylic, vinyl, or chlorinated carbon materials are being investigated by the Army, with tests now being conducted at Picatinny Arsenal.

3. *Report on Progress of Specification to Replace AXS-829 for Tin Plate and Terne Plate.*—H. F. Davidson distributed copies of two new specifications for size and top coatings. Both were issued September 18, 1956, as MIL-P-19602(N. Ord.) and MIL-E-19603(N.Ord.). He also informed the group that a new color chart book on TTC-595 has been issued. If not available at the Government Printing Office, interested members were invited to write to Mr. Davidson.

J. L. Flint of Ordnance Ammunition Command, Joliet, Ill., reported that interior finish varnish on booster casings is not entirely satisfactory. As a step in the manufacturing procedure, these casings are cleaned with a 2 per cent caustic soda solution and then a 150 degree Fahrenheit steam bath. This treatment loosens the coating and interferes with the inser-

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tion of the booster charger. Representatives of paint manufacturers who might have helpful suggestions should write to L. Washler, Army Chemical Center, Edgewood Arsenal, Md.

4. *MIL-STD-171(Ord.).*— Mr. Ammlung reported that this will be a basic reference manual to be supplemented by five other specifications to be applied for special conditions. The latter are now being put in a coördinated form, and it is expected that they will be issued in three to six months. It is hoped that all services will use the coördinated specification. Mr. Ammlung suggested that those interested obtain copies through their local ordnance district or write to him in care of the Chemical Coatings Laboratory, Aberdeen Proving Ground, Md.

5. *MIL-P-180(N.Ord.).*—It is reported that vinyl plastic plugs with an incorporated inhibitor are now being used successfully in 3-inch projectiles. It appears that these plugs will be used in 3- and 5-inch projectiles but not in smaller sizes.

6. *Electroplating Thickness Specifications.*—A year ago this Committee suggested that, in view of the increasing use of surface conversion coatings on cadmium and zinc electrodeposits, it might be possible to reduce the thickness of deposits in some cases. The Committee did not intend to recommend a change in thickness classifications in QQ-P-416 and QQ-Z-325 but rather to suggest that the end use be considered in selecting and applying the thickness specification.

On May 17, 1956, a communication was sent to the A.O.A. staff consultant by E. L. Holladay, Office of Chief of Ordnance, stating that in April an assignment was given to the Ordnance Materials Research Office (at Watertown Arsenal) involving a project to prepare a handbook on cadmium and zinc plating which will serve as a guide for ordnance design engineers. It is expected that this handbook will provide sufficient data and descriptive information to enable the designers to select suitable plating thicknesses for the various applications considering the required level of protection against corrosion and other technical factors.

It was also stated that ordnance experts have concluded that lesser thicknesses of zinc and cadmium could be used on many items and components. However it will be necessary to change the requirements on many detail drawings (and possibly specifications) for components rather than revise general specifications QQ-P-416 and QQ-Z-325.

7. *General Comments.*—J. L. Flint mentioned that in some cases of salt-spray failures on ammunition components the subcontractor who applied the paint could not be located. This caused delays in production schedules. He urged the paint suppliers in these cases to contact the subcontractor to straighten out the matter.

E. M. Kelley of Frankford Arsenal mentioned a problem of coating spiral-wrapped cases. The arsenal is searching for an air-dry varnish for touch-up of these cases. It was suggested that a catalyzed epoxy varnish might be satisfactory, but opinions were given that this material might cause gumming at 180-190 degrees Fahrenheit.

The following members and guests attended the twentieth meeting: H. L. Ammlung, Aberdeen Proving Ground, Aberdeen, Md.; S. J. Barber, E. F. Houghton & Company, Philadelphia, Pa.; J. J. Basch, Oakite Products, Inc., New York, N. Y.; William Blum, Pennsylvania Salt Manufacturing Company, Philadelphia, Pa.; Clarence Bremer, Oakite Products, Inc., New York, N. Y.; H. F. Davidson, Bureau of Ordnance, United States Navy, Washington, D. C.; Myron B. Diggin, Hanson-Van Winkle-Munning Company, Matawan, N. J.; Joseph L. Flint, Ordnance Ammunition Command, Joliet, Ill.

Also present were: E. M. Kelley, Frankford Arsenal, Philadelphia, Pa.; E. J. Kubis, Wyandotte Chemical Company, Wyandotte, Mich.; T. Curtis McKenzie, Klem Chemicals, Inc., Dearborn, Mich.; M. E. Powers, Wyandotte Chemical Company, Wyandotte, Mich.; Max B. Roosa, Parker Rust Proof Company, Detroit, Mich.; R. B. Saltonstall, Udylite Corporation, Detroit, Mich.; G. W. Seagren, Mellon Institute, Stoner-Mudge, Pittsburgh, Pa.; E. A. Stockbower, American Chemical Paint Company, Ambler, Pa.; F. L. Wagner, Glidden Company, Reading, Pa.; H. M. Werner, Glidden Company, Reading, Pa.; J. Weisberg, Frankford Arsenal, Philadelphia, Pa.; C. R. Cornthwaite, Office, Chief of Ordnance, U. S. Army, Washington, D. C.

Also present were: R. W. Bechard, Ord. Mats. Res. Off., Watertown, Mass.; F. M. de Beers, Jr., Enterprise Paint Manufacturing Company, Chicago, Ill.; L. F. Fall, Ord. Mats. Res. Off., Watertown, Mass.; V. G. FitzSimmons, U. S. Naval Research Laboratory, Washington, D. C.; T. F. Flint, Sherwin-Williams Company, Cleveland, Ohio; Leonard Frank, Ordnance Ammunition Command, Joliet, Ill.; J. F. Leland, Parker Rust Proof Company, Detroit, Mich.; Vincent C. Petrillo, General Electric Company, Philadelphia, Pa.; Claude G. Wall, E. F. Houghton & Company, Philadelphia, Pa.; Harry Ross Young, E. I. du Pont de Nemours & Company, Wilmington, Del.

After the meeting was adjourned at noon the group was served luncheon at the Officers' Club and then enjoyed a

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most interesting tour of the areas in Frankford Arsenal where shell and cartridge cases are manufactured.

Yorktown Chapter of the Washington Post Started at Langley Air Force Base

All the members of the lower peninsula of Virginia gathered at the Langley Air Force Base Officers' Club on December 10th to take part in the inauguration of the new Chapter of the Washington Post.

This new organization of the Association, presently designated the Yorktown Chapter, has been in the making for many months under the sponsorship of the members of the Technical Club of the Yorktown Mine Depot and their many friends. The Chapter expanded to include the Southeast or Hampton Roads section of Virginia, part of the Washington Post.

All the members and many guests and their ladies were on hand early for the reception to greet Maj. Gen. F. A. Hansen, Assistant Chief of Ordnance for Field Service. An undercurrent of excited interest in this formal opening affair was evident throughout the entire evening, and the enthusiasm of all the members was evident.

The meeting was called to order by George Svadeba, Naval Mine Depot, president of the Yorktown Chapter, who called on the Rev. Allan H. Fenner, pastor of St. Stephen's Lutheran Church, Williamsburg, for the invocation. After dinner was served, Toastmaster F. James Barnes, Sr., director of public relations of the State of Virginia, recounted many amusing tales appropriate to the affair, and introduced those at the head table.

The new charter of the Yorktown Chapter was presented to Mr. Svadeba by Capt. J. M. P. Wright from national headquarters, and the Chapter was welcomed officially into the Washington Post by Col. Franklin B. Reybold, president of the Washington Post. Mr. Svadeba expressed his thanks on behalf of the Chapter and gave public recognition to the hard-working leaders of the committees who had assisted in the organization. These were Dr. U. Cormier, B. C. Carr, T. B. McConnell, and E. E. Mason.

General Hansen spoke most interestingly on the subject, "These Changing Times." He described the great advances that Army Ordnance has made in its accounting and stock control in recent years by the use of several types of new computing machines. He explained how important this was in the face of constantly improving types of missiles and other armament and in the successful operation that had reduced the number of items in front-line depots by over 50 per cent.

Also seated at the head table were: Rear Adm. G. A. Holderness, Jr., commander, Norfolk Naval Shipyard; Lieut. Col. U. Cormier, assistant director of research and development, U. S. Naval Mine Depot; F. L. Boddicker, plant manager, Hercules Powder Company, Hopewell, Va.; M. Hopkins, general manager, American Oil Company, Yorktown.

Airborne Electronics and Proving Ground Instrument Committees Hold Meeting

Problems of instrumentation on the White Sands Proving Ground integrated range and airborne electronics problems peculiar to air developments were studied recently by two Committees of the American Ordnance Association composed of industrial leaders of the United States who will assist the armed services in solving them.

Forty-three members of the A.O.A.'s Airborne Electronics Committee and the Proving Ground Instrumentation Committee spent two busy days at the White Sands Proving Ground, N. Mex., Monday and Tuesday, October 22-23, 1956, and then visited the Holloman Air Development Command at Alamogordo, N. Mex., on Wednesday, October 24, 1956.

On the busy schedule for their visitors were listed technical discussions, tours of the establishments, briefings on operations, and a series of panel discussions. The visitors were also privileged to witness a regularly scheduled missile shoot.

The chairman of the A.O.A. Airborne Electronics Committee is Dr. S. W. Herwald, manager of the Air Arm Division, Westinghouse Electric Corporation, Baltimore, Md. Heading the Proving Ground Instrumentation Committee is L. W. Morrison, of the Bell Telephone Laboratories, Whippany, N. J.

Arriving at the White Sands Proving Ground on Monday morning, October 22nd, the visitors were cordially welcomed by Maj. Gen. W. E. Laidlaw, commanding general of White Sands Proving Ground, and his deputies for the Air Force and Navy; by Maj. Gen. L. I. Davis, commander of the Holloman Air Development Command; and by Capt. J. C. Parham, Jr., U.S.N., of the Naval Ordnance Missile Test Facility.

In responding to this welcome, Dr. Herwald stated that the A.O.A. members were "here to work, get the problems, take them back home with us, and then try to come up with the answers. We in

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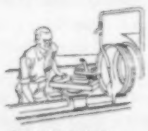

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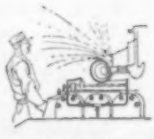

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Example of current Ordnance work—the Skysweeper. Production of this weapon has been continuous at the Ellwood City, Pa., plant since 1950.

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Post and Division Activities

the A.O.A. feel that we can contribute strongly to the solution of some of the problems which you gentlemen have here."

Introductory remarks were made by Dr. J. W. McRae, president of the Sandia Corporation, at Albuquerque, N. Mex., who is the deputy chairman of the A.O.A. Electronics Division; and by L. W. Morrison, heading the A.O.A. Proving Ground Instrumentation Committee for this meeting in the absence of regular Committee Chairman Hugh C. Carroll, General Electric Company, Schenectady, N. Y.

The principal orientation address was delivered by Dr. J. W. Muehlner, technical director, Systems Engineering Branch, Flight Determination Laboratories, W.S.P.G. In the course of his orientation talk Dr. Muehlner also developed the problems of stationary and airborne instrumentation at the proving ground.

After luncheon the visitors were taken on an extensive tour of inspection of the proving ground. On Tuesday morning, October 23, 1956, the visitors were given their choice of attendance at one or more of the following well-organized panel meetings which occupied the entire day.

"Computation and Data Reduction," Arthur E. Cooper, International Business Machines Corporation, chairman.

"Optical Systems and Position Determination," Dr. Carlton W. Miller, Perkins-Elmer Corporation, chairman.

"Telemetry and Remote Recording of Radar Information," O. H. Winn, General Electric Company, chairman.

"Firing Error Indicator Instrumentation and Missile and Aircraft Acquisition, with Special Emphasis on Electronics Problems," Herman A. Affel, Jr., Philco Corporation, chairman.

At 5:00 p.m. the buses left for Holloman Air Development Center—the visitors having dinner and spending the night at the lodge in Cloudcroft, a mountain hotel approximately midway between White Sands and Alamogordo.

Arriving at HADC on the morning of Wednesday, October 4th, the visitors were cordially welcomed by the commander, Maj. Gen. L. I. Davis. Maj. Archer W. Kinny, Jr., chief, Operations and Plans Office, gave an orientation talk outlining the principal operations of the Air Force Development Command at Holloman and cited the current problems in airborne electronics which they are experiencing.

The visitors were taken on a personally conducted tour of the station and witnessed current test activities.

Following a late luncheon there was held a meeting of all members of the two A.O.A. Committees for the purpose of resolving the many important problems of the two great service installations which had been discussed in the course of the 3-day technical sessions. It is the firm purpose of these A.O.A. Committees to endeavor to assist the armed services in every way in the solution of their problems.

The following representatives of American industry and the armed services attended the meeting: Herman A. Affel, Jr., Philco Corporation; Kenneth N. Bergan, General Mills, Inc.; C. A. Bicking, Carborundum Company; G. H. Christiansen, Radio Corporation of America; John J. Connors, RCA Service Company; Arthur E. Cooper, International Business Machines Corporation.

Also present were: W. D. Crawford, Air Arm Division, Westinghouse Electric Corporation; M. M. Dickinson, International Business Machines Corporation; Lieut. Comdr. A. A. Ebel, Navy Bureau of Ordnance; Thomas P. Fahy, Perkin-Elmer Corporation; M. S. Friedland, Reeves Instrument Corporation; Alan E. Gee, American Optical Company; Dr. E. B. Hales, General Precision Laboratory.

Also present were: E. B. Hammond, Jr., Sperry Gyroscope Company; Henry Handler, Office, Chief of Army Ordnance; Dr. S. W. Herwald, Air Arm Division, Westinghouse Electric

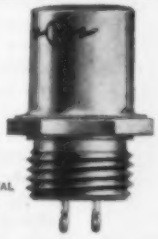
Air-to-air missiles must be guided from the mother plane during that brief interval between the closing of the firing switch and the instant the missile locks on its target. This is the critical moment when a success or failure depends upon the exactness with which computers in the mother plane direct the missile's flight. This is the moment when nothing is as vital to the kill as the precision voltage reference system controlling the computers.

For jobs like these, electronic manufacturers have learned to depend upon Hoffman Semiconductor Zener Reference Diodes. Engineered for use in all types of precision power supplies, these amazingly rugged silicon junction components typify the continuing leadership of Hoffman in the semiconductor field.

Hoffman subminiature Zener Diodes deliver predictable outputs to ±1 per cent over a temperature range from −65°C to +150°C—withstand ± 15G vibration, 100G shock and 50G acceleration loads under the severest humidity and altitude environments.

Whether for analog and digital computers, missile control, telemetering, limiting, clipping, voltage regulation or power supplies where size, weight and stability are critical requirements—Hoffman Semiconductor Zener Diodes are the indispensable voltage reference source.

Hoffman engineers will be glad to supply additional information on request.



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Corporation; Wayne Holden, General Electric Company; Robert M. Kalb, Remington Rand Univac; Lieut. Col. M. E. Kay, Eglin Air Force Base; Col. H. B. Kucheman, Jr., Eglin Air Force Base.

Also present were: Lieut. Col. J. S. Lambert, Air Research and Development Command; L. Richard Lankes, Eastman Kodak Company; Lieut. Col. W. A. Martin, Eglin Air Force Base; William P. McNally, W. L. Maxson Corporation; John C. McPherson, International Business Machines Corporation; Dr. James W. McRae, Sandia Corporation; Carlton W. Miller, Perkin-Elmer Corporation; James E. Mitchell, Naval Proving Ground.

Also present were: Walter J. Moe, Remington Rand Univac; L. W. Morrison, Bell Telephone Laboratories; Michael A. Moscarello, Ford Instrument Company; Col. L. M. Orman, Patrick Air Force Base; W. R. Orme, General Electric Company; N. C. Peterson, Rand Corporation; R. R. Potter, Naval Proving Ground; Dirk Reuyl, Ballistic Research Laboratories.

Also present were: T. C. Rives, General Electric Company; C. F. Schaefer, Norden-Ketay Corporation; Hugh M. Scott, Convair Division of General Dynamics Corporation; S. Merrill Skeist, Polarad Electronics Corporation; Sterling C. Spielman, Philco Corporation; William J. Tull, General Precision Laboratory; William G. Wurz, Yuma Test Station.

Rio Grande Post Hears Two Speakers at Meeting Held at Cortez Hotel, El Paso

The Rio Grande Post of the American Ordnance Association met Friday, November 23rd, in the Cortez Hotel, El Paso.

Opening the meeting, Maj. Gen. W. E. Laidlaw, commanding general, White Sands Proving Ground, president of the Post, expressed his appreciation of the presence of civilian members, noting that the El Paso area is lacking the type of industry which generally provides a strong civilian and industrial tie with Ordnance.

Both speakers, Lieut. Col. M. D. Sloane, chief, Range Services Division, White Sands Proving Ground, and Chris Fox, vice-president of the State National Bank of El Paso and a regional Vice-President of the A.O.A., gave life to their talks on serious subjects by interspersing much wit and good humor which kept their audience alert and attentive to the important messages each delivered.

• **MYRON J. HAYES** of Rochester, N. Y., a former vice-president of the Eastman Kodak Company and for many years a regional vice-president of the American Ordnance Association, died at his winter home, Deerfield Beach, Fla. on November 22, 1956.

Mr. Hayes was with the Eastman Kodak Company for approximately forty years. During World War II and for some time thereafter he was general manager of the company's camera works where lenses and other optical devices were produced for Navy Ordnance. He was also a former director of the Stromberg-Carlson Company and the Central Trust Company in Rochester.

Mr. Hayes throughout his career was an ardent supporter of the American Ordnance Association and a firm believer in a strong national defense. He was always more than ready to help in A.O.A. programs on the local or national level. In his passing the Association has lost a true friend and loyal follower.

Mast of **SHELBY SEAMLESS TUBING**
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provides high strength and corrosion resistance for coaxial antenna

The Type 3C06 Coaxial Colinear Antenna*, consisting of three half-wave vertical dipoles arranged colinearly and operating on a frequency range of 152-176 MC, is especially suitable for patrol car broadcasting. The three vertically arranged dipoles exhibit a gain of 5 to 6 db over a standard single dipole, and produce a low angle of radiation with equal radiation in all directions.

This 13½-foot, 40-pound antenna is supported by a mast made of Shelby Seamless Tubing (USS Stainless Steel) running through its center. In addition to possessing the tensile strength to withstand 100-mile-per-hour winds, this stainless supporting mast has high corrosion resistance—will not flake from oxidation and cause short circuits.

In such critical applications where superior strength, uniformity, dimensional accuracy and corrosion resistance are needed, Shelby Seamless Tubing of USS Stainless Steel is consistently chosen to meet the requirements. Shelby Seamless Tubing, available in a wide range of diameters, wall thicknesses, various shapes and steel analyses, is produced to exacting standards by the world's largest manufacturer of tubular steel products. If you wish, our engineers will make a study of your requirements, and will help you apply Shelby Seamless Steel Tubing to your specifications.

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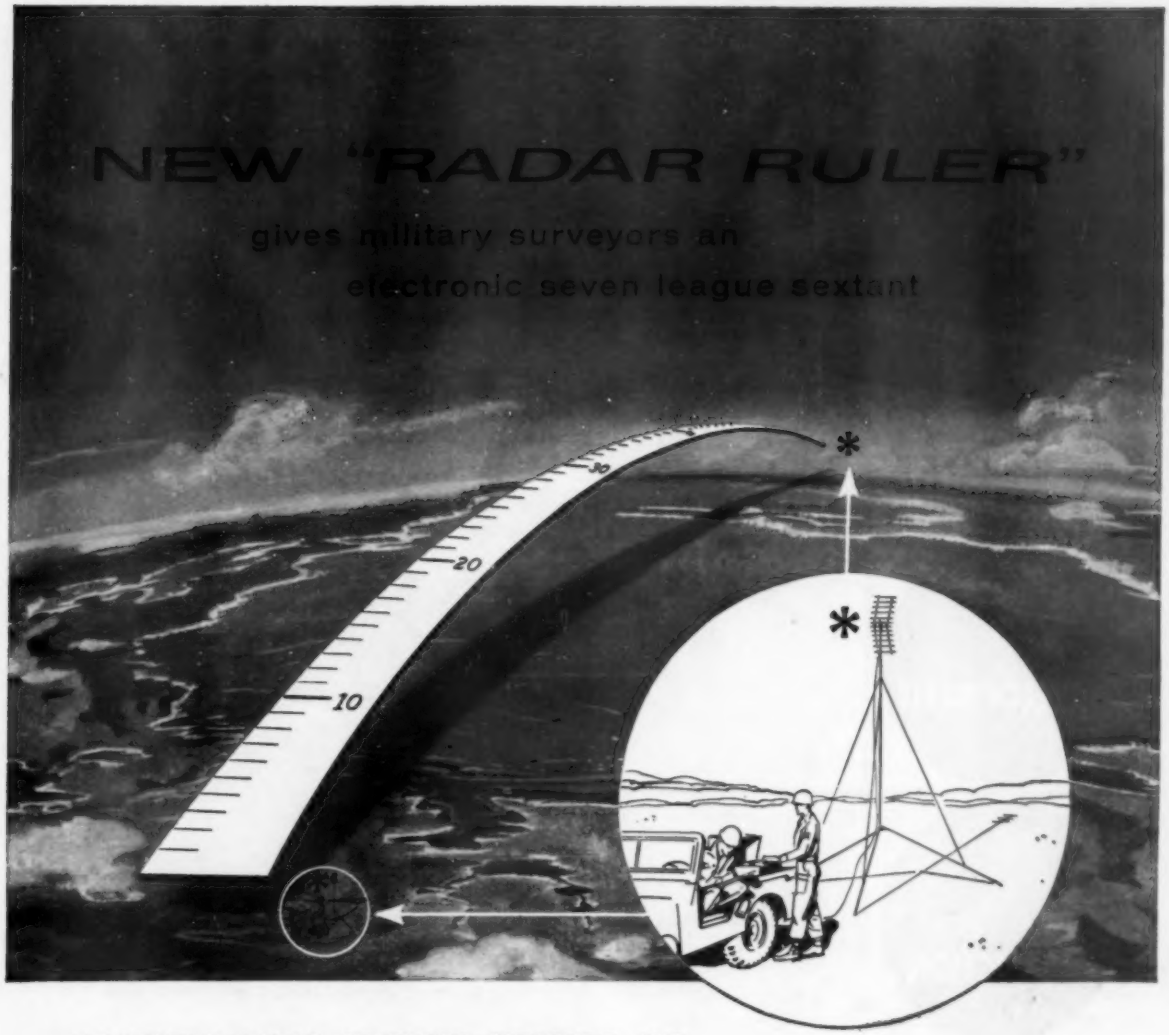

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For the *first time*, surveyors are freed from short-sighted optical equipment. Unlike old-fashioned surveying tools, the "radar ruler" pierces through fog, darkness or dense foliage, electronically pacing off distances of 1 to 50 miles, precise to within a few meters!

This new general-purpose surveying instrument was developed by Motorola's Military Electronics Laboratory for the Signal Corps Engineering Laboratories, Fort Monmouth, N. J. The entire operation can be handled easily and quickly by unskilled personnel.

This self-calibrating system uses two identical portable radar stations which bounce a signal back and forth thousands of times each second. High-speed computers automatically provide the data necessary to measure off the distance.

Here is just one more example of the equipment now being developed by Motorola for many varied military applications.

3 suitcases and a 25 ft. collapsible antenna comprise the entire equipment

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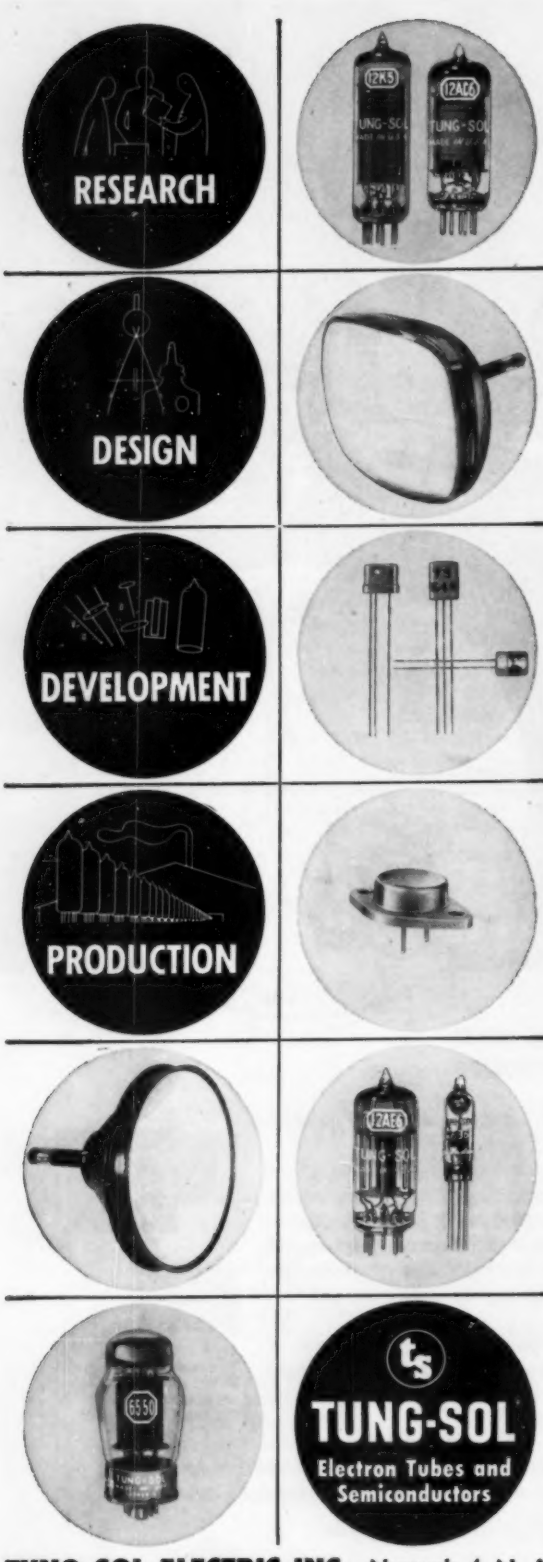

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NEW DEVELOPMENTS

ELECTRONIC SENTRY

A new extremely lightweight, portable radar which enables a front-line foot soldier "to see with his ears" was disclosed recently by the Army. The device was designed at the Sperry Gyroscope radar laboratories to give the infantry its own localized battle-area surveillance of enemy movements despite a curtain of battle smoke, darkness, or fog.

Extreme lightness and ruggedness was attained by eliminating entirely the usual radarscope, which produces visual signals on a luminous screen. Instead, a moving enemy vehicle or foot patrol produces audible sounds of distinctive character in the headphones of the set.

Lightweight radar tracker and plotter team.

This highly mobile gear is self-contained in a drum-shaped metal case, only 14 inches high and 14 inches long, weighing 25 pounds. In its present version, the low power needed is supplied by a compact, lightweight motor-generator, easily transportable on foot by a second member of a 2-man observation team.

The new radar set can reveal the difference between fixed and moving targets at varying ranges up to three miles. In the hands of trained ground operators it also distinguishes a vehicle from moving personnel and indicates whether a single vehicle moves on track-type treads or wheels.

QUIET SUBMARINE

The U. S. Navy recently commissioned its newest submarine—one of the quietest of all time—the modern 1,800-ton attack sub, U.S.S. DARTER (SS 576) made by the Electric Boat Division of General Dynamics Corporation. The DARTER's stealth will be enhanced by confining the roar of its Diesel engines to a sound-isolated compartment. The engines are operated by remote control from a soundproof cab or console.

One of the ship's main assets will be an airplane or "joystick" type control, providing one-man operation of the vessel below the surface and contributing toward smoother and easier diving and maneuverability. In addition there are wide aisles between berths, individual bunk lights and ventilation, and such

moving metal... BLUE ANGELS' style

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With maximum separation of five feet between each plane, the "Blue Angels" demonstrate precision tactical techniques of naval aviation at speeds of 500 mph and better. This famous team of Navy pilots has thrilled millions of aviation enthusiasts with its "minimum altitude" performances of close order precision flying.

To a constantly increasing number of manufacturers, particularly aircraft and jet engine builders, moving metal by The Cincinnati Milling Machine Company's *Hydroforming* and *Hydrospinning* processes is equally dramatic. Formerly difficult-to-make aircraft, engine, missile and other components are being produced in rapid development time . . . with savings of 50% and more in tooling, materials and labor. These part shapes range from simple to highly complex, formed from a wide range of metals. For detailed information on Hydroforming and Hydrospinning, call in a Process Machinery Division field engineer.

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luxury items as an ice cream machine, automatic record player, cinemascope movie screen, and even 4-place dining room tables for crew comfort.

In addition to such conventionally powered submersibles as DARTER, the Navy now has fifteen nuclear submarines already built or under construction. The most recent keel was laid for the TRITON, which will be a radar picket submarine and the largest undersea craft ever built.

Most unusual of the atomic fleet being built is the SKIPJACK. It will be the first A-sub built with the ALBACORE teardrop-shaped hull.

In addition, the Navy has been authorized to build a nuclear-powered guided-missile cruiser and the nuclear plant for an aircraft carrier.

NUCLEAR DEFENSE SYSTEM

A nuclear bombardment defense system has been developed by the Army to guard military installations and industrial plants against surprise attack. This Radiological Defense Warning System is already in operation at one major military headquarters. Further installation of the electronic setup is planned for important Air Force bases. It will also be used by Civil Defense at strategic locations across the Nation.

The warning system detects any atomic or hydrogen blast or poison-gas attack endangering an installation, tripping relays that instantly sound warning horns, close blast doors, turn off gas lines, start radiologically filtered ventilation systems, and trigger a series of other protective devices.

Using three different detectors to eliminate chance of failure, the warning instruments include a gamma-ray detector, a device sensitive to certain blast pressures, and a thermal detector operated by infrared radiation from fission or fusion.

The detectors are small aluminum cylinders placed atop steel towers surrounding the site to be protected. They are wired to an underground control board.

GUIDED MISSILE DESTROYER

One of the world's most versatile warships—the U.S.S. GYATT (DDG-712)—was commissioned recently. Capable of destroying an enemy attack whether by supersonic airplane or modern submarine, the GYATT is the first of the Navy's guided-missile destroyers. In addition to the most modern antisubmarine ordnance, the vessel has twin Terrier guided-missile launchers. The GYATT is a converted 2,250-ton World War II type destroyer and is the first of 16 destroyer-type vessels planned for the Navy's nuclear-powered, guided-missile fleet.

As well as being the Navy's first guided-missile destroyer, the GYATT is also the Navy's first warship to have a stabilization system added to her hull structure. This system is designed to eliminate much of the rolling that is characteristic of small ships. It consists of two 45-square-foot retractable fins extending out from midships, well below the waterline.

UNDERWATER A-WEAPON

The Navy's first underwater atomic weapon, "Lulu," was recently announced by Vice Adm. W. V. Davis, Jr., Deputy Chief of Naval Operations for Air. It is reported that it has a lethal range of several miles, is capable of being exploded at the considerable depths which modern submarines can reach, and is launchable either from an airplane or a surface ship.

RUSSIAN MISSILES

A new series of air-to-surface missiles, designed especially for use against shipping, has reportedly been developed in the U.S.S.R. The new family of rockets was developed in an electronics center near Moscow by a small group of German electronic experts according to a report. The missiles are designated Comet 1, 2, 3, and 4.

The Comet 4 has an approximate range of over ninety miles. For the first sixty

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Typical applications of Harvey Impact Extrusions are illustrated below. Harvey Impacts have a smooth surface and require no machine finishing for most ordnance, airframe, and missile applications. Harvey's integrated services provide an economical, quality product that meets all specifications of high strength, light weight, resistance to corrosion and heat, critical tolerances in wall thickness, maximum heat conductivity, and low unit cost.

Harvey Aluminum leads in impact extrusions

Harvey pioneered in the impact extruding of intricate configurations. This experienced leadership, plus technical know-how and the most advanced facilities, are available for your own specialized design requirements. The integrated Harvey engineering team of research, design, metallurgy, and quality control will expedite your product from drawing board to finished product quickly, efficiently, economically.

If you have a design that calls for hollow, closed end sections... high strength... zero-degree walls and surfaces... unusual length to diameter ratios, integral ribs, fins, and bosses... close tolerances... with volume production, low unit cost... *your Harvey Field Engineer will be happy to show you how Harvey Impact Extrusions can help solve your design problems.*

ROCKET FIN with integral guiding vanes impacted as a one-piece unit from alloy 7075-T6. This impact extrusion provides transverse physical properties equal to longitudinal properties and a high degree of dimensional accuracy with close tolerances. Similar symmetrical designs in diameters up to 10 inches can be impact extruded.

LANDING GEAR COMPONENT provides highest physical properties, greatly reducing material and machining costs. The impact, obtainable in various lengths, is made from aluminum alloys which assure optimum internal grain structure. This impacted piston replaces costly method of hogging out bar stock or machining a forging. Diameters of barrel are held to close tolerance dimensions with superior surface finish.

ROCKET MOTOR TUBE with integral formed bulkhead for application in rockets. Length to 8 feet, diameter 6-8". Tube has a thicker cross-section at both ends to accommodate threading. This type of Harvey Impact Extrusion in high strength aluminum alloys offers high transverse properties for added hoop strength.

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Harvey is a leading independent producer of quality aluminum products in all alloys and sizes: Rod and bar, pipe, tube, hollow sections, press forgings, forging stock, impact extrusions, structurals, special shapes, extrusions, screw machine products and other aluminum products. Harvey is also producing similar items in titanium and steel.

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THE whole Farquhar engineering-designing effort is directed toward making Farquhar Presses extremely efficient *even on short-run operations*. Farquhar's new triple-acting press with electric magnetic controls is typical of this designing plan. The electric controls of this press provide for fast, easy set-ups and fast, accurate cycle operation—two important advantages that guarantee higher production profits regardless of the size of the run.

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miles it follows beam guidance from the launching aircraft. In the last portion of its flight it is guided by radar echoes from the target. The radar signal is originated by the mother plane and is beamed at the target in constantly shifting frequencies to nullify the effects of jamming. Receivers in the missiles are tuned to shift with each change in frequency.

TRANSPARENT RUBBER

Transparent rubber is being tested by the Air Force as a way to beat the heat on airplane windshields. The rubber will be used as an interlayer in windshield glass of new supersonic Air Force airplanes. With this new material it is expected that airplane windshields will be able to withstand twice as much heat from air friction at high speeds.

Frictional heat can reach such intensity that the flexible, transparent plastic now used as a windshield interlayer softens and begins to lose strength. When its strength is gone, the interlayer is unable to prevent the glass from shattering if cracked. The new rubber interlayer is being developed for the Air Research and Development Command's Wright Air Development Center, Dayton, Ohio, by the Dow Corning Corporation, Midland, Mich. It retains adequate strength up to 350-degrees Fahrenheit as compared with the 180-degree Fahrenheit limit on present plastic interlayers.

X-RAY MICROSCOPE

An X-ray microscope—a powerful new tool for research into hitherto unexplored fields of metals, foods, chemicals, and criminology—was announced recently by the General Electric Company. Under development for more than four years, the X-ray microscope promises to reveal hidden facts concerning corrosion and the effect of foreign materials in metals, the soundness of electroplated coatings, and the effects of various processes on the behavior and structure of metals.

Secret of the microscope lies in the extremely tiny size of the focal spot, which is bombarded by electrons and thus caused to give off X-rays. This target is only forty millionths of an inch in diameter. X-rays emanating from such a small spot fan out in all directions and hence magnify any object which they pass through. The new microscope achieves magnifications up to 1,500 diameters and at the same time discloses the inner structure of the object being examined.

LIGHTWEIGHT RIFLES

Fairchild Engine & Airplane Corporation recently announced the development of a series of new lightweight, corrosion-resistant firearms including:

1. The AR5 30½-inch survival rifle that breaks down into a 14-inch, 2¼-

pound package with storage of the barrel and action in the fiber glass and plastic foam stock. It will float if dropped into water. The Air Force has adopted this gun as its standard survival weapon.

2. The AR10 automatic rifle, known as the Armalite, currently being tested by the Army as a possible successor to the Garand semiautomatic rifle. The AR10 weighs 6.85 pounds, almost 3 pounds less than the Garand and less than either of 2 other automatic rifles currently under consideration by the Army—the Springfield-developed T44 and the Belgian FN.

Basic features of the new Fairchild guns are an aluminum barrel of special alloy with a stainless-steel liner, an aluminum and stainless-steel action, and a stainless-steel clip.

MISSILE TESTER

An ultrarapid missile tester which enables highly mobile guided missile troops to strike targets faster and more effectively, was disclosed recently. At the push of a button, this rapid automatic checkout equipment (Race) dynamically tests each missile unit, performing in minutes the hundreds of preflight tests that would consume vital hours by more conventional means. A master console employs lightning-fast computer elements to check out

Console of the Race.

all units of the entire missile system, provide necessary maintenance, and supply critical information for command decision during final countdown.

Where trouble exists, Race pinpoints the faulty component, flashes its location and replacement time on a console screen, and immediately delivers a computer punch card spotting the plug-in replacement for technicians. Race precludes false answers by testing itself continuously dur- the missile checkout and confirming all answers at the master console. If trouble does occur within Race, it warns the operator immediately, naming exact rack,

(Continued on p. 656)

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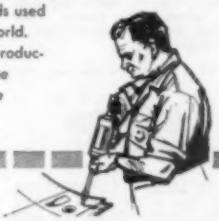

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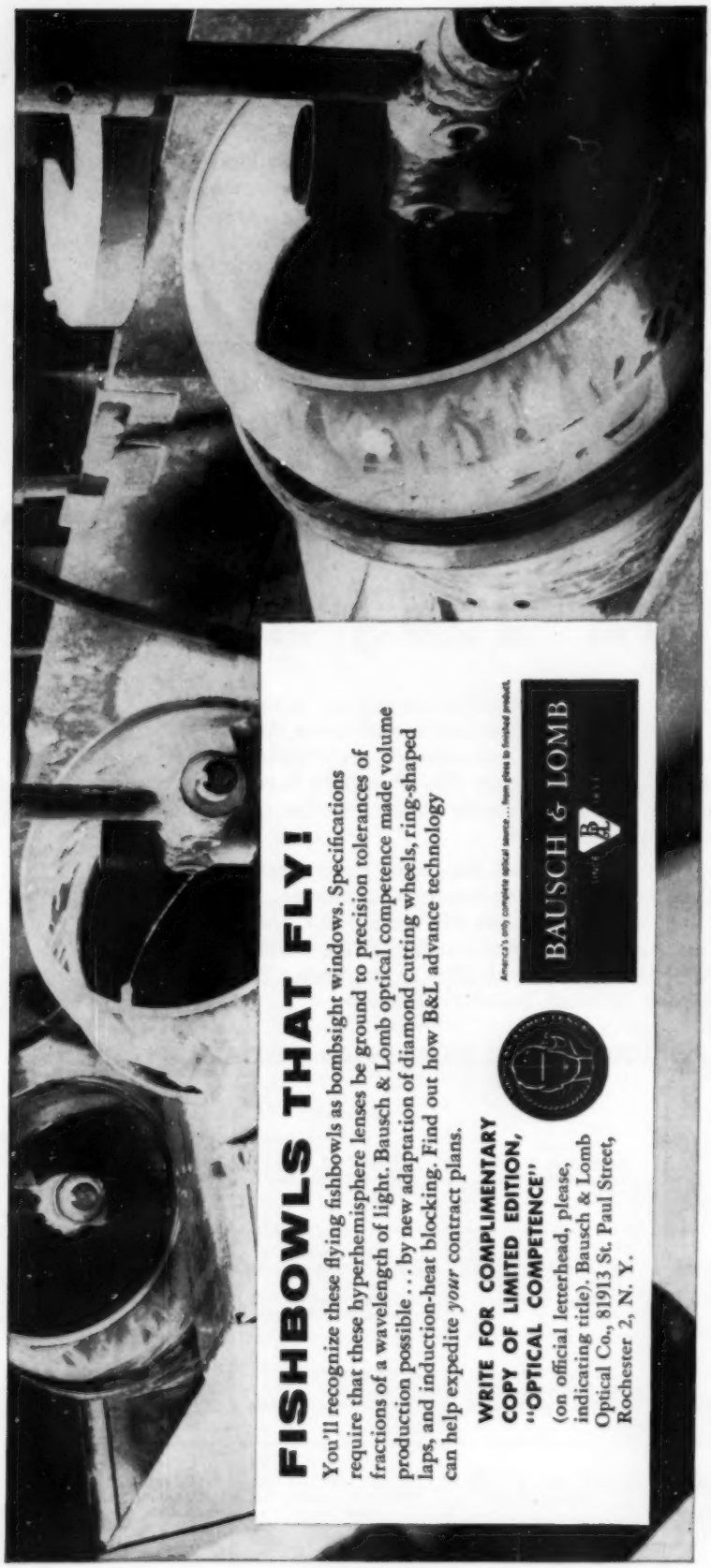
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New Developments (Contd.)

drawer, and chassis location of its own faulty plug-in component for immediate replacement.

RESTRAINED FIRING

A new milestone in the complex missile preflight testing program at White Sands Proving Ground was passed recently with the first "restrained firing" of a rocket and booster combination.

The history-making experiment was conducted at the 300,000-pound Static Test Facility. A Nike-1 booster, attached to the completely assembled and fully instrumented missile, was fired as if for a test flight. But the missile was physically restrained from taking off and flying by means of an ingenious elastic suspension system.

The firing culminated nearly two years of work on the designing, building, and perfecting of both the restrained firing method and the heavily reënforced concrete and steel structure necessary to perform it.

It marked the beginning of a new series of tests expected to be a great stride forward in the preflight shock and vibration testing program on Nike-1. It may also have paved the way for similar testing of other missiles. This could result in substantial savings, since the less expensive restrained firings might in some instances take the place of actual test flights.

TERRAPIN ROCKET

The first flight of an extremely lightweight and cheap 2-stage rocket to an altitude of 80 miles at 3,800 miles an hour was reported recently by the National Advisory Committee for Aëronautics. The research missile is called the Terrapin, after the mascot of the University of Maryland, which administered the project.

The rocket is 15 feet long, only 6¼ inches in maximum width, and weighs 224 pounds. The Guided Missiles Division of the Republic Aviation Corporation, Mineola, L. I., designed and built the Terrapin. The rocket was designed to take atmospheric measurements that cannot be taken by the Vanguard space satellite, which is to be launched this year.

AN ABLE WEAPON

One of the Navy's latest antisubmarine weapons, designated Weapon Able, is a rapid-firing rocket fired from a launcher that can be trained and operated without requiring the ship to turn and head for the submarine before taking offensive action. The 500-pound Able covers a larger ocean area more effectively than the old type depth charges and has a variable range. The launcher has a flash deflection shield which diverts the exhaust blast upward, thus protecting the deck areas.

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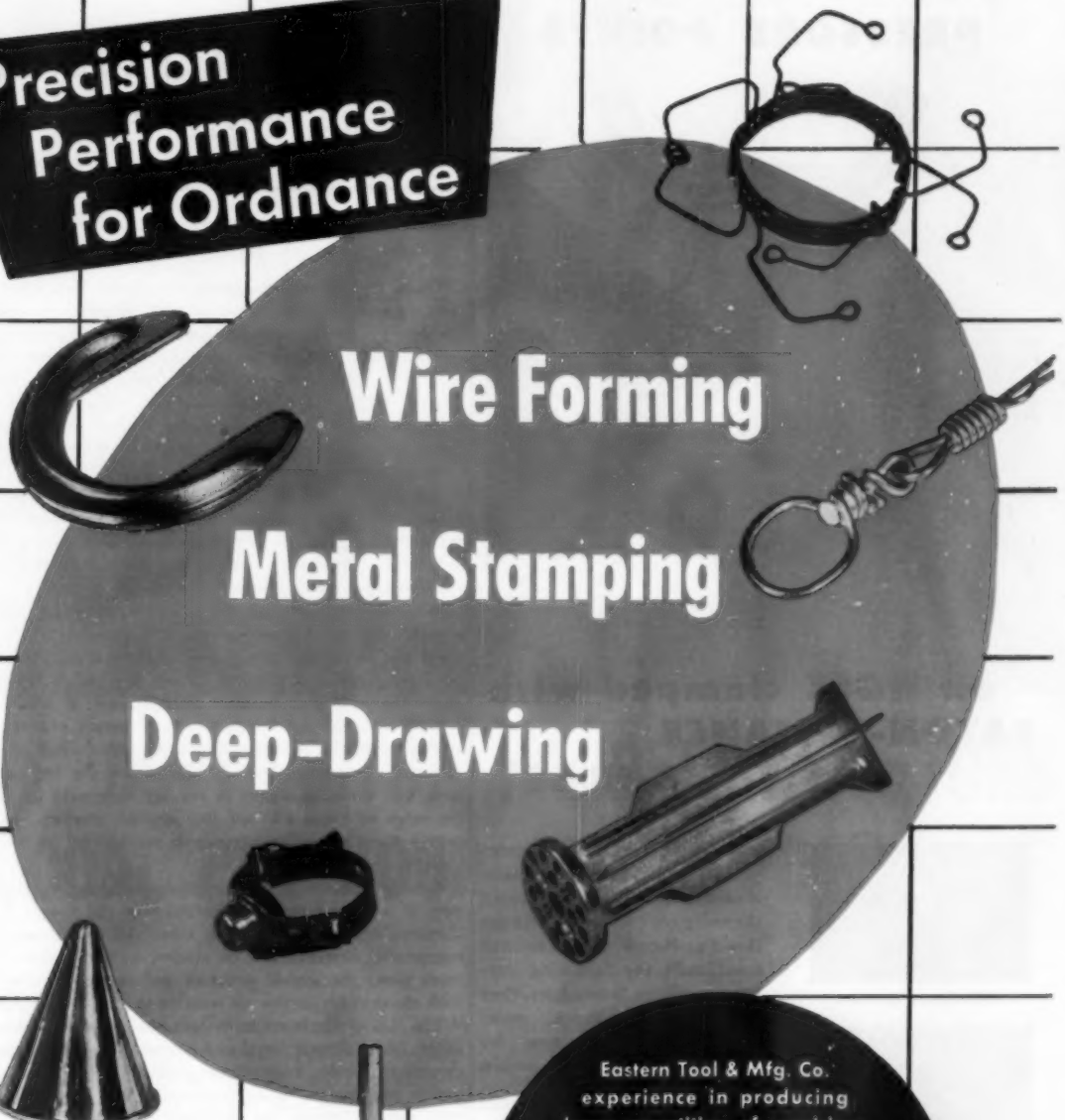

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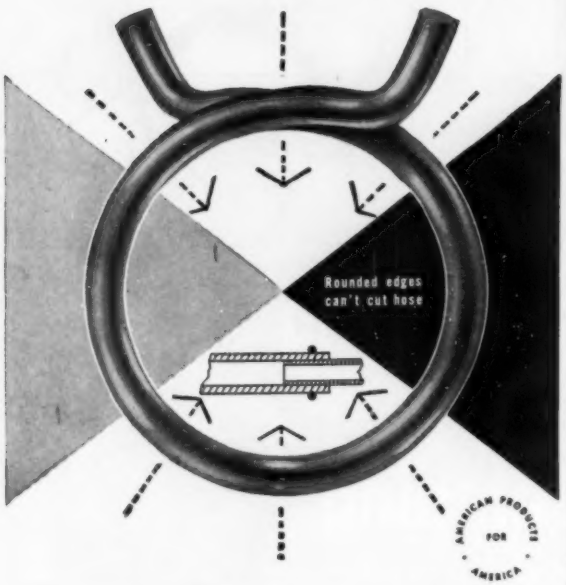

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MATERIALS PROGRESS

George S. Brady

Trends in Technical Research.—Analysis of the trends in technical research now going on in this country does not confirm the gloomy views recently expressed in much of the press and relayed even into Congressional Committee hearings. The Office of Defense Research and Development estimates the present rate of research at $5 billion annually, of which 40 per cent is stated to be for military projects. *Chemical Week* places the figure lower, around $3 billion, with 50 per cent financed by the Government.

But these figures are based on tabulated budgeted research. Much study and investigation, technically research, is done in the manufacturing plants by production and testing staffs, and very much of the work done by the staffs of smaller companies is technically research, though not classed as such.

Whatever the budgeted figure may be in comparison with the research figures of other nations, it is apparent to any one who visits the plants and laboratories that American research today is increasingly dynamic and is not lagging. It is difficult to gauge the amount of research directly aimed at materials, but it can be said that most research, even purely product research, has an impact and effect on industrial materials.

Military equipment is specialized, but the mechanisms and units that make up a piece of military equipment are technically the same as those that go into civilian products, so that the money spent on military research is reflected in the improvement of civilian goods.

A basic study of solid-state physics is being undertaken at the new $6 million materials laboratory of the *Union Carbide & Carbon Corporation* at Parma, Ohio. All of the metals and the nonmetallic elements will be studied with the idea of learning more about the atomic structure and developing new materials with physical properties not possible to obtain in ordinary alloys.

The idea of intermetallic compounds is not new. Several companies have already developed refractory hard metals, such as chromium boride, molybdenum disilicide, and nickel aluminide, which are true molecular compounds, not alloys, and point the way toward solving the problems of high strength, hardness, and oxidation resistance at the extremely high temperatures needed for the jet-engine age.

But this field of research is still in its infancy, and Union Carbide believes that more basic study is needed on the atoms themselves with the possibility of rearranging the electrons or the atomic combinations to produce differences in the metals as dramatic as the atomic change in carbon which yields the soft graphite or the hard white diamond from the same element.

The new $5,000,000 Metals and Ceramics Building added to the *General Electric Laboratory* at Schenectady, and the new *Westinghouse Research Laboratories,* are fitted with the most modern equipment for scientific research. The General Electric laboratory also includes equipment for studying the techniques of processing and pilot-plant development, such as vacuum induction melting, and hot- and cold-working equipment.

The Westinghouse laboratories are designed on a modular basis with the "modules," or individual laboratories, fully equipped with all services—power, hot and cold water, natural gas, vacuum, compressed air, and continuous supplies of oxygen, nitrogen, and hydrogen—for use by an individual scientist or capable of being combined into laboratories of any size for special projects.

(*Continued on p. 660*)

CAT* D9 TRACTOR HANDLES 907 TONS OF COAL PER HOUR ON 150-FOOT PASS

The B. C. Cobb plant of Consumers Power Co., in Muskegon, Michigan, consumes 2400 tons of coal daily. Since the coal is brought in by boat, enough must be stockpiled to carry through the five winter months when the Lakes are frozen over.

Here's where a giant Cat D9 Tractor proves its worth. It pushes coal into a hopper on the stockpile and also feeds coal to the traveling crane that loads conveyor belts for transportation to the powerhouse. On a 150-ft. pass the D9, with its 20-ft. Balderson light material bulldozer, handles up to 907 tons per hour. And on a 250-ft. pass the hourly production is 633 tons.

The picture shows the D9 handling a blade load of 25 tons with ease. This king-size 'dozer is designed and constructed with the strength, balance and rolling action to match the power and traction of the "King of the Crawlers."

In stockpiling coal or other loose materials, one D9 has proved it can outwork two of the largest tractors of other makes. Its weight—33 tons including the blade—assures good compaction. It gives you 320 HP at the flywheel. Available with either torque converter or oil clutch drive, the D9 is as easy to operate as smaller tractors. And it's built with Caterpillar ruggedness for long, dependable work life.

In the D9 you have a tractor that can do any number of small jobs as well as big ones. It saves money because it gets each job done faster, more easily, and moves on to the next one.

Get the facts about this big-capacity machine from your Caterpillar Dealer. He has numerous case histories to prove its value. Let him give you an on-the-job demonstration of what it can do. And remember—you can depend on him for prompt, complete service and original Caterpillar parts.

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MODERN
HEAVY-DUTY MATERIALS
HANDLING EQUIPMENT

Materials Progress (Contd.)

An example of the trend in product research that is having great effect on materials is the new $7,000,0000 Research and Development Center of the *Continental Can Company* in Chicago. This Center has about 600 employees, nearly half of whom are scientists. Savings in tin have been one of the important unheralded accomplishments of such laboratories. During World War II the steel companies were able to make great savings in tin by the introduction of electrolytic tin plating, but more recently the can makers have effected large savings with synthetic resin coatings.

It is estimated that seventy-five per cent of all cans are now coated with resinous enamels. *American Can Company* has recently developed an enameled steel can for foodstuffs in which tin is used only for the soldered side seam.

Even the soldered side eventually may be eliminated in metal cans for packing such products as beer, soft drinks, coffee, pet foods, and motor oils, since polyamide and epoxy resin cements have been developed that are satisfactory for seaming. Through these efforts alone, the strategic importance of tin has decreased greatly since the period of the war.

High-Temperature Materials.—There is much healthy competition in the operations of the present research projects. While some laboratories are aiming at intermetallic compounds for jet-engine use, the *Tungsten Institute* believes that the logical direction in which research should be turned to obtain suitable high-temperature alloys is toward tungsten, a metal with a melting point above 6,000 degrees Fahrenheit and a recrystallization point at 2,300 degrees Fahrenheit.

The Institute has placed a contract with the *Stanford Research Institute* at Menlo Park, Calif., for the possible development of high-temperature alloys for jet-engine and missile use. Working on this project is R. H. Thieleman, who developed the X-40 alloy during World War II.

He is reported to have stated that while vast sums are being appropriated to develop new engines, missiles, and aircraft, the types of materials needed to make them successful are not now available, and that this is "almost a discredit to our American ingenuity."

The *Naval Ordnance Laboratory* at Silver Spring, Md., has been pushing hard on basic research on a wide range of materials for electronics, mica substitutes, insulation, and heat-resistant alloys. Its new Thermenol alloy, aimed primarily for jet-engine use, appears now to have application in many civilian products, especially to conserve nickel.

The alloy contains no strategic materials. It has 3 to 4 per cent molybdenum, with 15 to 16 per cent aluminum, and the balance iron. It has better strength above 450 degrees Fahrenheit than Titanium Rc 130A, and it can replace 17-7PH stainless steel for compressor blades for jet engines, and is 15 per cent lighter in weight.

Wire and ribbon elements show long life for intermittent temperatures in excess of 2,000 degrees Fahrenheit, and they are envisualized for use in heating elements as well as for skins for supersonic missiles and aircraft.

The rolled alloy has high hardness and wear resistance, and, since it is resistant to fuming nitric acid and highly oxidizing solutions and to food acids and sodium hydroxide solutions, it has wide use possibilities to replace strategic alloys in the chemical-processing industries.

Progress in Rubber.—Troubles at the Suez Canal and in the Far East that could cut down imports have not seemed to cause worry in the rubber industry. In fact, the *Natural Rubber Bureau* has

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Gear teeth get in line when he takes a hand

R. L. Thoen, right, explains faulty tooth conformation on a minute gear which has been enlarged 100 times in this king-sized projector. Gear specialist on the engineering staff of the Mechanical Division of General Mills and author of numerous technical papers, Thoen makes gear trains perform with uncanny accuracy. He helps design and build the special machines which make such accuracy routine work at the highly specialized plant.

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General Mills Pioneers Scientific Frontiers One of General Mills' numerous research projects involves the behavior of metals in space flight. Here a scientist determines the "sputtering" or disintegration rate of molybdenum at 200 miles above the earth. The metal is under fire from atoms moving at 25,000 m.p.h.

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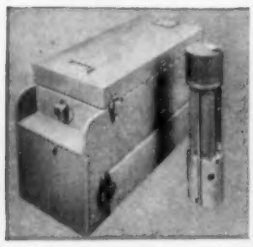

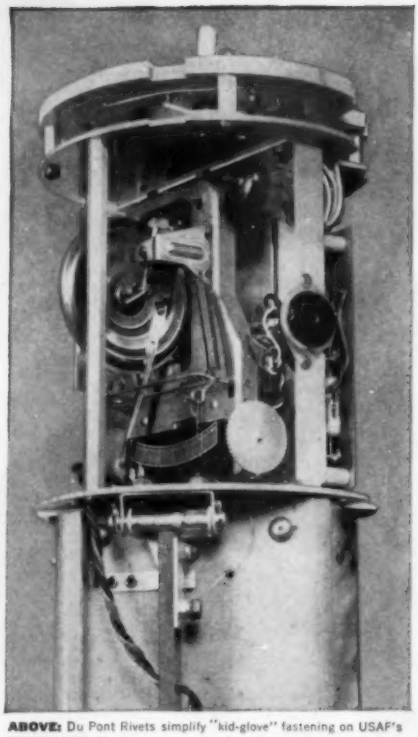

ABOVE: Du Pont Rivets simplify "kid-glove" fastening on USAF's DROPSONDE. No backing, no after-finishing, no danger of damaging delicate mechanisms. AT LEFT: DROPSONDE, with its calibration box.

NO BACKING POSSIBLE, YET—

DU PONT RIVETS EASILY FASTEN DELICATE ASSEMBLIES IN STRATOSPHERIC "WEATHERMAN"

You're looking at the DROPSONDE: amazing new device manufactured for the USAF by the Friez Instrument Div. of the Bendix Aviation Corporation. Ejected from a "jet" high in the stratosphere, this electronic "weatherman" gathers and transmits temperature-pressure-humidity data back to the plane. There, a receiver-recorder takes over, interpreting and charting the impulses as DROPSONDE parachutes to earth. An accurate weather "snapshot" for flying missions and missile tests.

Since fastening's required within or around delicate mechanisms, *with no backing possible*—standard methods were "out." A knotty fastening problem, but the Baltimore firm found the answer in Du Pont Blind Expansion Rivets. Today, Friez workmen need fasten only from Rivet's head side—need only a heated iron to set 'em fast and sure—and mechanisms stay untouched. Takes only seconds, and these rugged fasteners stay put despite impact of landing.

• • •

GOT A FASTENING PROBLEM? Try Du Pont Aircraft Blind Expansion Rivets. You can expand up to 20 a minute in blind or open work—no backing required. Get the full story in our free, handy booklet. Write E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilmington 98, Delaware.

DU PONT AIRCRAFT BLIND EXPANSION RIVETS

DU PONT *A Product of Du Pont Research*

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Materials Progress (Contd.)

appeared disturbed for some time about the decreasing importance of natural rubber.

It recently called the attention of its members to the fact that no more than forty per cent natural rubber is now being used in American rubber products, and that if there were an emergency this percentage could be greatly reduced. It also warned that "successful development of processes for the production of this rubber (synthetic polyisoprene) would further reduce the dependence on natural rubber."

The *Goodrich-Gulf Company*, Avon Lake, Ohio, has a new synthetic rubber which is an oriented isomer polymer of isoprene (the natural rubber) and closely resembles natural hevia rubber. Goodrich's Amerpol SN has already been used in large truck tires and has given good service.

Esso Research and Engineering Company, working with the *Armstrong Tire Company*, West Haven, Conn., has been testing new all-butyl tires and has found them superior to GR-S rubber or natural rubber tires in abrasion resistance and ozone resistance. The butyl tires also eliminate squeal in turning corners. The rubber is a copolymer of isobutene and isoprene (ninety-eight per cent isobutene and two per cent isoprene). A new butyl latex gives good bonding of the rubber to the tire cord.

With competition in mind, the *International Rubber Research Board* in London has been activated and plans a strenuous program of research to improve production of natural rubber and to find new markets. It should result in a general improvement of the whole rubber situation.

Improvements in Steel.—Though no spectacular developments in new steels have been announced recently, mills have been putting much effort into producing better steels. Results from the introduction of vacuum melting furnaces have been such that engineers maintain that old tables listing the physical qualities of standard steels have been obsoleted. Cleaner steels from vacuum melting, combined with improved controls in working, have greatly increased fatigue life, tensile strength, ductility, and corrosion resistance.

The manganese type of stainless steel, "on the shelf" for many years because of its poor working qualities, has now been developed with a relatively small amount of nickel to a point where the grades designated as Type 201 and Type 202 are commercially comparable for many uses with the standard 18-8 steels.

In fact, the whiter color given by manganese makes them preferable for such uses as railway car and truck body construction and restaurant equipment. The

DOW CORNING CORPORATION

Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 9

Giant Log Stacker Attains Peak Power With Class H Motors

Engineers designing large electrically powered equipment are attaining more power per pound while gaining the many advantages of placing the power unit closer to the work by using motors insulated with Dow Corning Silicones. An excellent example is the giant Electric Log Stacker produced by R. G. LeTourneau, Inc., Longview, Texas.

A separate high torque a/c motor connects directly to every point of load — lift fork, hold-down tusks, boom tilt and rear axle steering. And there is a separate d/c motor inside each of the four rubber-tired drive wheels. A diesel-generator set supplies power to any or all motors on demand.

The work potential of these mechanical giants is worthy of Paul Bunyan. A single bite of the lift forks conveys up to 25 tons of logs; one stacker can move more logs in 5 minutes than three conventional yard lifts can handle in 30 minutes!

To provide maximum power and reliability, every working motor — like all drive motors on all LeTourneau "electric wheel" equipment — is Class H insulated with Dow Corning Silicones. *No. 35*

Encapsulating Electrical and Electronic Parts with Silastic is the subject of a data sheet that provides details of handling heat-vulcanizable and room-temperature-vulcanizable silicone rubbers in such applications. *No. 36*

All New — 1957 Guide to Dow Corning Silicones is a twelve page, fact-filled catalog which briefly describes the silicone products of interest to most industries. Containing latest data and information, the guide is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these unique engineering materials. *No. 37*

Improve Percolator With Silicone Laminate At No Extra Cost

Designers who make imaginative use of silicones to increase the life and reliability of toasters, steam irons and other appliances can often do so without adding a single penny to the cost of the finished product. A recent example is provided by Aluminum Goods Manufacturing Company, manufacturer of Mirro-Matic Percolators.

While Mirro-Matic's terminal pin insulators made of phenolic had proven satisfactory in normal use, the designers reasoned that abuse of the percolator could loosen electrical connectors and cause arcing. Phenolic is also prone to absorb moisture when splashed or dunked by careless users, raising a further possibility of insulator failure.

The risk of such breakdown, however, was entirely eliminated by the superior dielectric strength, heat and moisture resistance of silicone-glass laminates manufactured by Taylor Fibre Company. The moisture absorption of silicone laminate, for example, is only 0.02% compared with about 2% for phenolic.

And, because of the higher physical strength of silicone laminate, plain low cost stampings could be used instead of expensive molded parts. A further saving was produced by reducing breakage during assembly.

The score: greater reliability for the Mirro-Matic Percolator without adding a cent to production costs! *No. 39*

COIL BOBBINS OF SILASTIC RESIST HEAT, HIGH VOLTAGE

Combine high temperatures and high voltage and you'll quickly expose any weak link in an electrical insulation system. That's what happened when technicians at Transformer Engineers, Pasadena, California, tested conventional choke coils intended for use on aircraft fire control apparatus.

The tests revealed that conventional coil bobbins all too often developed "electrical punctures" in the tube-to-flange joints when subjected to 15,000 volts at 140 C operating temperatures.

The problem was overcome, however, with

bobbins molded in one piece of Silastic, the Dow Corning silicone rubber. Featuring excellent thermal stability and dielectric strength after prolonged exposure to high temperatures, their one-piece construction avoided tube-to-flange joints entirely. Over 3000 of them have been put into service in the last two years; not one failure has been reported to date. *No. 38*

Silicone Insulated Conductors, a reprint from WIRE AND WIRE PRODUCTS, describes and compares eight different types of silicone insulated wire and cable currently available for different applications. *No. 40*

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Materials Progress (Contd.)

amount of nickel used in Type 201 is 4 per cent, and that in Type 202 is 5 per cent. The manganese content is 6 and 8 per cent, respectively, with the chromium at 17 and 18 per cent.

High-Purity Silicon.—To reduce cost in the production of the high-purity silicon needed for rectifiers and transistors, *Bell Telephone Laboratories*, New York, N. Y., has applied the zone refining technique to rods of commercial-grade silicon, which grade is obtainable at less than half the cost of the pure semiconductor grade.

A liquid silicon zone is made to traverse a vertical silicon rod which is surrounded by a flow of water vapor and hydrogen. The water vapor oxidizes the boron and other impurities, and the oxidation products are evaporated off. Refining has hitherto been difficult and costly, as the molten silicon picks up impurities from the crucibles.

Graphite for Rockets.—Office of Technical Services Report PB 121084 describes a new dense adherent coating for graphite nozzles in rocket motors which will protect against high-velocity oxidizing gases up to a temperature of 3,500 degrees Fahrenheit. The coating is produced by applying molybdenum disilicide powder suspended in a phenolic resin vehicle. After curing the resin, the coated part is heated in a neutral or reducing atmosphere of about 4,000 degrees Fahrenheit, which leaves a glazed surface of hard refractory molybdenum disilicide.

Incidentally, *Climax Molybdenum Company*, New York, N. Y., has issued a new bulletin describing the properties of molybdenum disilicide for turbine blades, nozzles, and other heat-resistant uses.

Tiny Battery.—A new electric battery of tiny size developed by the *Union Carbide & Carbon Corporation* at the National Carbon Division, Parma, Ohio, has a solid electrolyte of silver iodide, with one terminal of silver and the other of vanadium pentoxide. There is no liquid, and the battery has long life. One cell generates 0.5-volt, and a battery of 200 cells to generate 100 volts measures only ⅛-inch in diameter and 1 inch long.

New Nylon Products.—The *Keystone Plastics Company, Inc.*, Union, N. J., has a new line of large-diameter, thin-walled nylon tubing as a substitute for strategic alloy-metal tubing for petroleum and chemical processing plants. It has high bursting strength and is resistant to hot chemicals up to about 300 degrees Fahrenheit.

A new line of nylon bearings in 39 plain and flanged sizes from ¼- to 1-inch diameters is being offered by the *Climax Metal Products Company*, Cleveland,

Ohio. The nylon bearings need no lubrication, and they will support a load of 200 pounds per square inch at a velocity of 525 feet a minute. As they resist attack by solvents or chemicals, they are suitable for use in equipment for the foodstuffs and chemical industries.

A new plant to produce Nylon 6 for molding compounds and extrusions is being installed at Henderson, Ky., by the *Spencer Chemical Company*. Nylon 6 is made from caprolactum, which is now made synthetically from benzene, phenol, and cyclohexane, thus eliminating dependence on imported castor oil.

Aluminum in Construction.—Reduction in maintenance costs was one of the chief reasons for the selection of aluminum as the construction material for the 74 large overhead sign trusses on the Ford and Lodge expressways near Detroit. The trusses, 50 to 100 feet in length, are made from welded aluminum tubes with diagonal tube bracing. The bridges are supported by 7- and 8-inch aluminum tubing. Bases are aluminum sand castings and aluminum plate. The trusses, built by the *Planet Corporation*, Lansing, Mich., have an average weight of about 3,300 pounds, and require no painting.

Engineers responsible for construction of the new 236-mile Kansas Turnpike favored aluminum because of reduced maintenance costs as well as the easy installation of the lightweight units. The 1,056 major signs and the 1,000 "trail blazers" marking turn-offs, entrances, and service plazas, are all of aluminum, as also are the 500 mile markers and the 25,000 reflective delineators. The 106,000 feet of bridge railing has cast-aluminum posts and 3½-inch extruded aluminum tubular rails. It was estimated that conventional iron railing costs 25 to 30 cents a foot for painting, while the aluminum will never need painting.

National Bureau of Standards has been running corrosion tests on aluminum alloys continuously for more than twenty years, with samples being removed at intervals for physical tests. The Bureau has found that the noncopper alloys, such as Alloy 3004 and Alloy 5254, have proved highly resistant to corrosion without loss of properties. Alloy 3004 contains 1.04 per cent manganese and 0.89 per cent magnesium, while Alloy 5254 has 3.57 per cent magnesium and 0.25 per cent chromium.

Carbon Piping.—*National Carbon Company* is now offering its Karbate impervious carbon and graphite piping with a glass fabric armor on the outside to give structural strength and to prevent excessive leakage in the event of cracking. The piping comes in diameters from 1 to 4 inches and in lengths up to 9 feet.

Bendix

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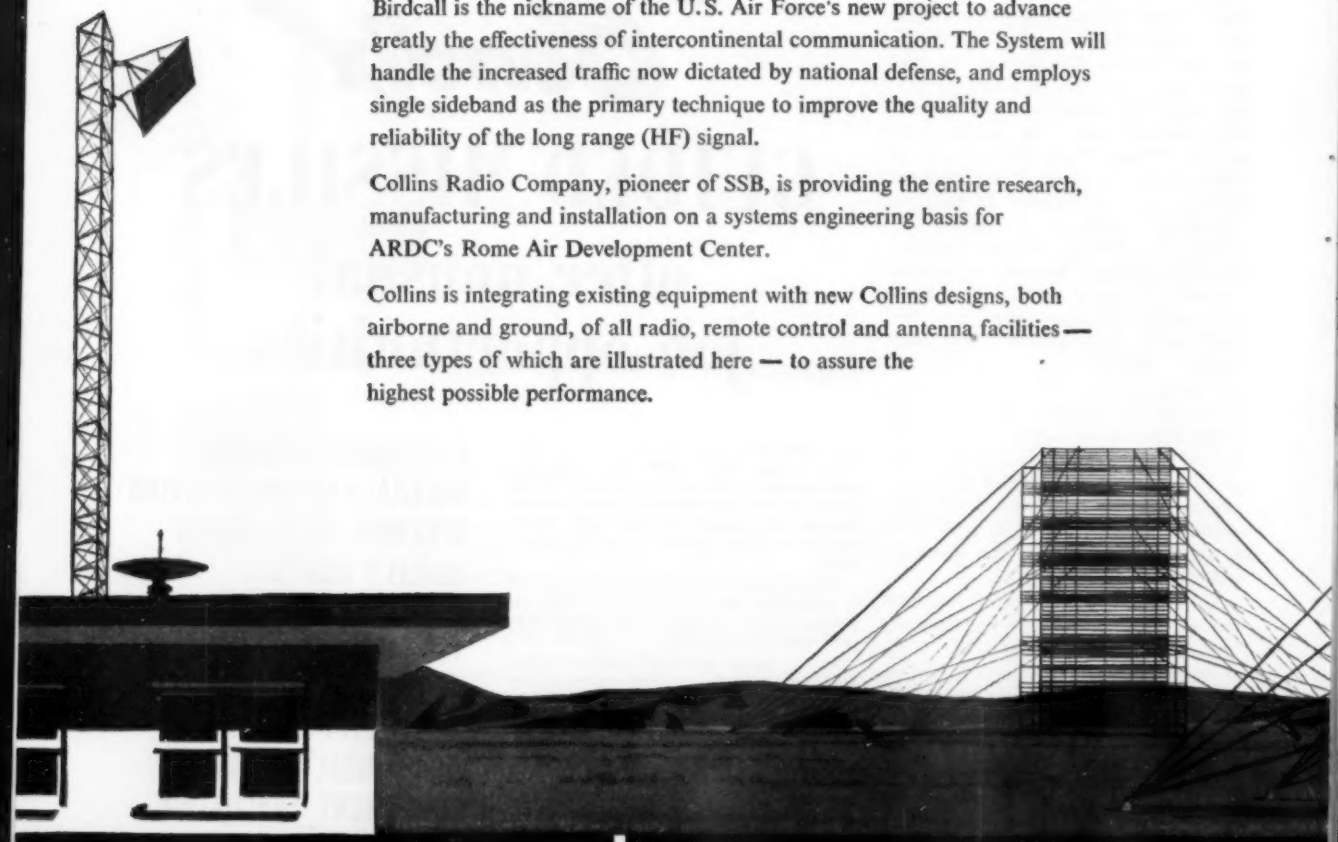
Single Sideband employed in new Air Force project to improve

Birdcall is the nickname of the U.S. Air Force's new project to advance greatly the effectiveness of intercontinental communication. The System will handle the increased traffic now dictated by national defense, and employs single sideband as the primary technique to improve the quality and reliability of the long range (HF) signal.

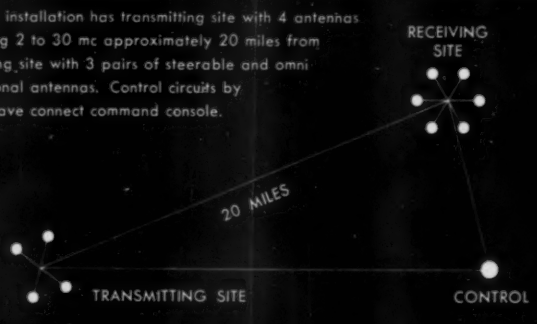
Collins Radio Company, pioneer of SSB, is providing the entire research, manufacturing and installation on a systems engineering basis for ARDC's Rome Air Development Center.

Collins is integrating existing equipment with new Collins designs, both airborne and ground, of all radio, remote control and antenna facilities — three types of which are illustrated here — to assure the highest possible performance.



Transmitting and receiving facilities are the most advanced in the art, many of which represent over 10 years of intensive development in SSB.

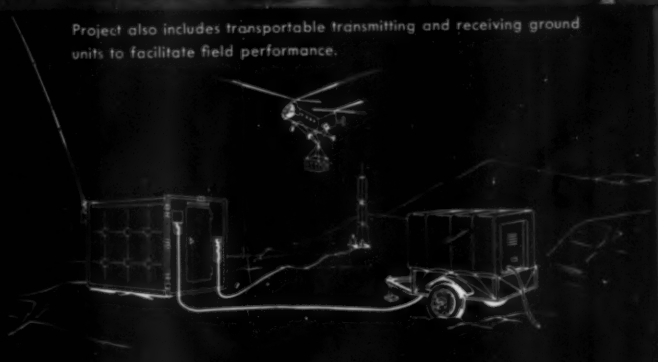
Typical installation has transmitting site with 4 antennas covering 2 to 30 mc approximately 20 miles from receiving site with 3 pairs of steerable and omni directional antennas. Control circuits by microwave connect command console.



CALL

long range communication

Project also includes transportable transmitting and receiving ground units to facilitate field performance.



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ARMAMENT ELECTRONICS

Dr. W. S. Carlson

A well-known weekly television program, documented from the files of a metropolitan police department, has dramatized a series of robberies in which the criminals frustrated efforts at immediate pursuit by jamming the police radio communication system.

According to the televised narrative, one of the partners in crime had access to a radiophone transmitter which could be tuned to the police call frequency. The unattended station was controlled by a clock in accordance with a predetermined schedule. Careful timing of their actions enabled the criminals to take flight as the clandestine transmitter went into operation.

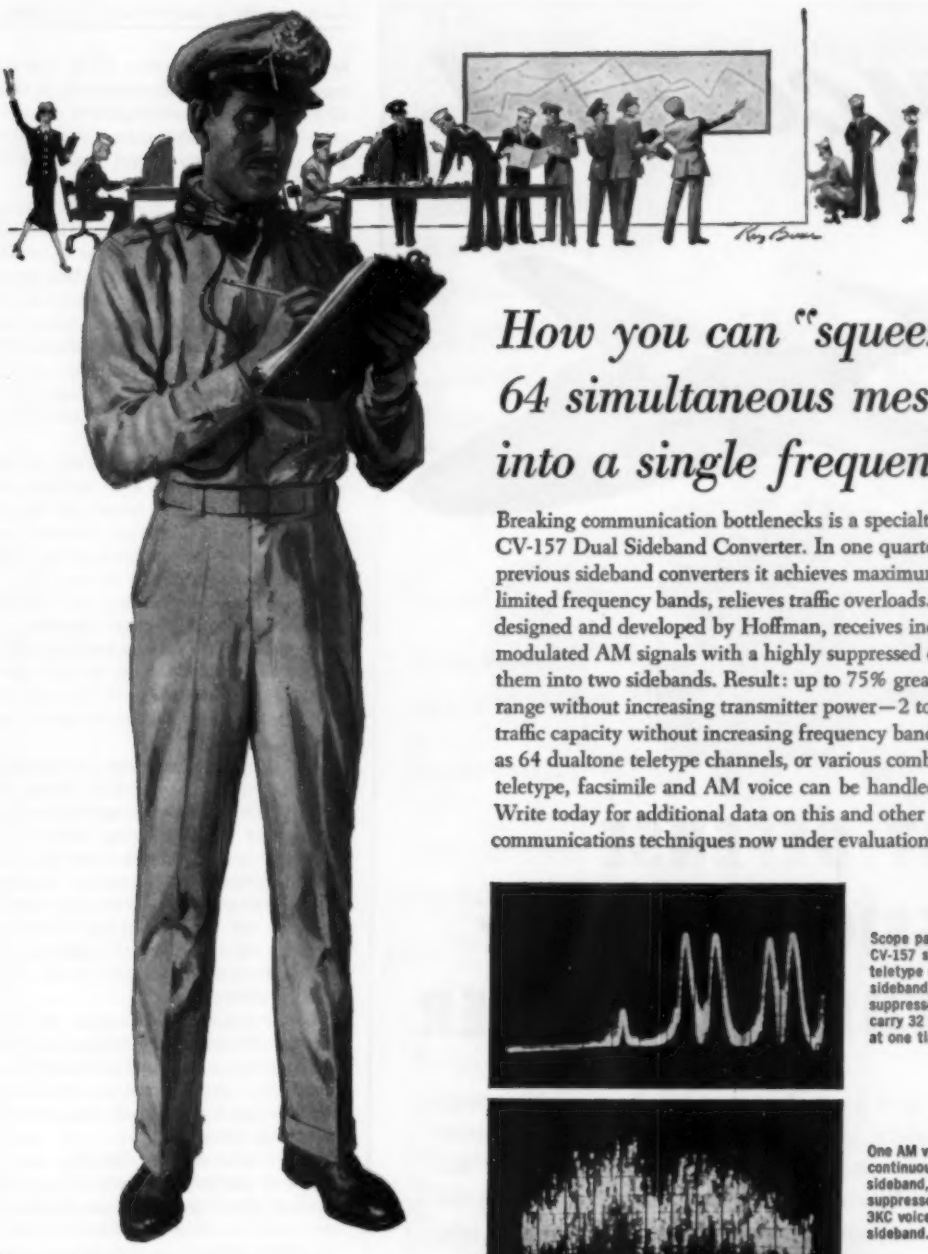
After an interval just sufficient to prevent coördinated pursuit of the criminals by the police, the outlaw transmitter was silenced to avoid, if possible, disclosing its location. Except to note that the police had recourse to the slower, but less vulnerable, channels of communication afforded by the telephone system, further details of the story are not immediately relevant.

Performance of military radio communications equipment and other items of electronic armament may also be adversely affected by interference due to other sources of electromagnetic radiation. Precision tracking radars, as employed in air defense systems, are particularly vulnerable because of the broad frequency spectrum and high data rate required to track high-speed targets.

Functionally, the conventional radar configuration is a signaling system in which the receiver is isolated from the transmitter except for coupling due to back scatter and reflections from external objects. Suppression of direct coupling between the receiver and its associated transmitter does not, however, provide for isolation from other transmitters.

The useful sensitivity of a radar receiver is ordinarily limited by noise originating in the receiver itself. However, under some conditions, extraneous radiation may establish the threshold. Effects which may result even from unmodulated c-w interference at the radar r-f frequency will illustrate.

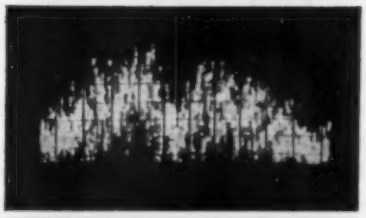
If account were to be taken only of response to pulsed signals in designing a radar receiver, direct coupling between the second detector and the video ampli-



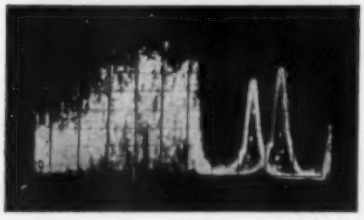
How you can "squeeze" 64 simultaneous messages into a single frequency

Breaking communication bottlenecks is a specialty of the Hoffman CV-157 Dual Sideband Converter. In one quarter the space of previous sideband converters it achieves maximum use of today's limited frequency bands, relieves traffic overloads. The CV-157, designed and developed by Hoffman, receives independently modulated AM signals with a highly suppressed carrier and splits them into two sidebands. Result: up to 75% greater effective range without increasing transmitter power—2 to 32 times more traffic capacity without increasing frequency bandwidths. As many as 64 dualtone teletype channels, or various combinations of teletype, facsimile and AM voice can be handled by the CV-157. Write today for additional data on this and other advanced communications techniques now under evaluation at Hoffman.

Scope pattern taken from Hoffman CV-157 showing two dualtone teletype channels on upper sideband, carrier partially suppressed. Each sideband can carry 32 teletype channels at one time.



One AM voice channel (made by continuous vowel sound) on each sideband, carrier completely suppressed. CV-157 carries two 3KC voice channels on each sideband.



AM voice on lower sideband, dualtone teletype channel on upper. With suitable multiplexing equipment, the CV-157 handles 64 simultaneous dualtone teletype channels.

ALL PHOTOS UNRETOUCHED FROM PANALYZOR MODEL SB-8

Electronics and Mechanical Engineers

Significant developments at Hoffman in the fields of VLF, HF, VHF, UHF, forward scatter and tropospheric communications, single sideband and advanced ECM techniques have created important positions for engineers of high calibre. Please address inquiries to Vice-President of Engineering.

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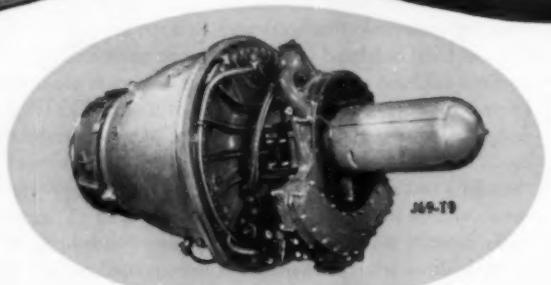
TEMCO TT-1



LATEST DEFENSE ASSIGNMENT for CAE TURBINE POWER

Performance and ease of control join hands with a high degree of safety in Temco's TT-1 primary jet trainer, which the Navy has ordered into production after exhaustive tests. This modern tandem two-seater is designed to condition the student's reflexes to the piloting of jets, from the very start. It is a matter of pride and gratification to CAE that this newest addition to our country's military training equipment flies with Continental J69-T-9 gas turbine power.

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fier would be satisfactory. Peak limiting required for intensity-modulated display (PPI), could be accomplished by impressing the negative video pulse on the grid of a properly biased sharp cutoff pentode amplifier.

However, in the presence of strong c-w interference the d-c output from the detector might be sufficient to drive the first video stage to cutoff. In this event, information from the pulsed signal would be largely lost. The d-c component due to c-w interference can be removed by insertion of a high-pass filter between the detector and amplifier. In this way, satisfactory video response is obtained over most of the pulse spectrum.

Distortion due to attenuation of the low frequencies by the filter becomes important only if pulse length discrimination is required. A linear detector has been assumed—*i.e.*, amplitude of the video pulse is proportional to the envelope of the i-f pulse—independently of interference level. Given a linear detector and high-pass filter to prevent blocking of the video amplifier, distortion of the signal pulse as a consequence of c-w interference at the radar carrier frequency can be avoided.

However, it should not be concluded that unmodulated c-w has no effect. Because of pulse-to-pulse changes in the phase relation of the interfering wave trains, the video pulses will fluctuate in amplitude. Moreover, intermodulation products of i-f receiver noise with c-w interference increase the video noise by a factor of $\sqrt{2}$ for linear detection. Significance of these effects on radar performance is not readily generalized.

Limiting can also take place in the i-f section. Strong c-w interference may drive the amplifier to saturation, thus reducing incremental gain to zero. In consequence, neither signal pulses nor receiver noise appear in the video.

To overcome the difficulty, various forms of automatic gain control have been devised which reduce i-f amplication for the c-w interference without a corresponding reduction in gain for pulsed signals. Sufficient bias is applied to restrict operation to the peak of the i-f cycle.

Although saturation is thereby avoided, only the high-frequency components of the pulse spectrum are represented in the amplified signal. Effectiveness of back-bias arrangements in coping with strong c-w interference therefore depends on the i-f bandwidth.

Modulated interference may also be encountered. Qualitatively, it is obvious that interference which closely resembles either the expected signal or normal receiver noise is likely to impair radar performance. Noise-modulated c-w interference would introduce additional noise into the radar receiver and thus raise the sig-

nal threshold for target detection or tracking.

If the amplitude of the (noise) modulating function is small in comparison with the c-w carrier amplitude, the sidebands will extend uniformly above and below the carrier to frequency limits which depend on characteristics of the noise generator. As the modulation fraction is increased, limiting due to finite carrier amplitude modifies the noise spectrum.

A small modulation fraction implies relatively low noise power in the sidebands but close simulation of true noise. A large modulation fraction implies high sideband power and also significant departure from the spectrum of true noise. Limiting and frequency clipping may radically modify the signal-masking properties of the interference.

Electronic interference can degrade the desired signal in several ways. If the interference is sufficiently strong, saturation of the receiver may reduce incremental sensitivity to zero. Interference may mix with the desired signal, making recovery of information difficult or even impossible. When it is not feasible to cope with the problem at the source, advantage must be taken of differences between the interference and desired signal.

The i-f back-bias and video-filter techniques mentioned in connection with unmodulated c-w interference are based on the difference between frequency spectra of the interference and desired signal. After appropriate frequency translation, the c-w interference can be suppressed by filtering. It was noted, however, that loss of information carried by the low frequencies must be accepted.

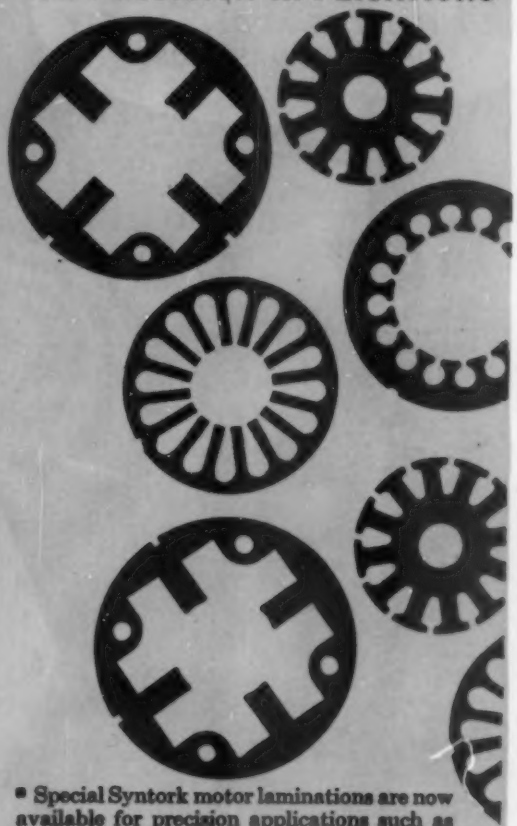
Noise-modulated c-w interference is less easily rejected. Again, discrimination between wanted and unwanted signals is based on spectral differences. Bandwidth of the receiver is made large enough to ensure utilization of frequencies in the pulse spectrum which are not represented in the interference. Because modulated c-w more closely simulates the spectrum of desired signal plus noise, rejection entails a greater loss of information than does suppression of unmodulated c-w.

If the interference spectrum were completely to overlap the signal spectrum, discrimination solely on a frequency basis becomes impossible. However, complete specification of the signal and interference spectra requires that, in addition to amplitude and frequency, account be taken of relative phases of the several components.

It thus becomes possible, at least in principle, to distinguish between interference and the desired signal on the basis of relative phase. Coherent detection circuits developed for this purpose are variously known as synchronous, homodyne, and synchrodyne detectors.

MAGNETIC METALS COMPANY

FOR PRECISION APPLICATIONS



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Electromagnetic Cores and Shields

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EITHER WAY, POWER STEERING MAKES GOOD BUSINESS SENSE.

THE CASE FOR POWER STEERING ON TRUCKS!

The trend to power steering on trucks is based on one very practical reason—operators of trucks equipped with power steering have invariably found that the added safety and greater operating efficiency of their vehicles have demonstrated that power steering is indeed a sound investment.

Truck drivers using power steering report less tension and fatigue in normal driving and appreciate the positive control that blocks road shock from chuck holes and prevents loss of control if the truck is forced out on a soft shoulder.

The dispatcher knows the importance of regularly maintained schedules. He is quite aware that with power steering drivers are more relaxed and are better drivers than tired drivers. Thus, power steering not only reduces the hazard of road accidents, but helps the driver to maintain established schedules through better vehicle control.

In short, power steering, by saving time and money, contributes materially to a more profitable operation.

Truck manufacturers are always eager to offer their customers features that will make truck operation safer and more profitable and, at the same time, give their dealers every selling advantage.

That's why more and more truck manufacturers are offering performance-proven Bendix* Power Steering as original factory equipment.

If you would like to know why power steering for trucks is perhaps even more logical than power steering for passenger cars, we have prepared an interesting folder on the subject.

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—First test of the *Vanguard* earth satellite vehicle was fired late in the fall.

The third-stage solid-propellant rocket will later be placed atop a modified *Viking* rocket and fired at the Air Force missile range in Florida. The combination is expected to reach an altitude of 200 miles but purpose of the test is not to establish an orbit but to check out propulsion systems and gather upper-atmosphere data.

General Electric Company reports that it is putting the finishing touches on its first-stage *Vanguard* motor. Called the X405, it produces a thrust of over 27,000 pounds and has a burning time of about 150 seconds. Burning liquid oxygen and hydrocarbon fuel, the motor is fed by hydrogen-peroxide-driven turbopumps. The compact size and high output of the engine are a result of higher-than-usual operating temperatures and pressures.

Minneapolis-Honeywell is completing another part of the *Vanguard* rocket—a hermetic integrating gyro. Built along the lines of the familiar toy gyro, its job will be to keep the rocket on its course and gradually bring the final stage to a near parallel course to the surface of the earth.

Unlike the toy, the gyro will weigh over four pounds and will be encased in a volume about the size of a can of peas. The gyro will be bathed in a special oil bath to dampen rocket vibrations. A transistorized circuit will maintain the gyro at constant temperature.

In addition to standard rocket components, even the mousetrap will take part in the satellite program. Mousetrap-type springs, it has been found, are a simple way of closing access hatches on the satellite rocket.

Missiles.—Firing of what may be the first *Jupiter* 1,500-mile-range rocket has been reported. The test took place in September and Army spokesmen stated that the aim of the test was system check-out rather than accuracy or distance. Tests took place at the Florida test range at Cocoa.

Meanwhile, Army Ordnance has released some details on the *Redstone* medium-range missile. The 200-300-mile missile has a diameter of about 70 inches and is some 69 feet long. Power comes from a North American Aviation liquid oxygen-alcohol rocket engine. Production of *Redstone* is being rushed by Chrysler Corporation at the Navy-owned Industrial Reserve Plant at Warren, Mich. Also coöperating in the Army Redstone Arsenal program is Reynolds Metals Company and Ford Instrument Company.

What may be the most critical phase in the development of the intercontinental ballistic missile—atmospheric reëntry—is receiving additional impetus. General Electric Company is a holder of a multimillion-dollar program for arming and fuzing missile warheads for Army Ordnance Picatinny Arsenal Atomic Applications Laboratory. General Electric also has engaged in a large program for the Air Force ballistic missile program pertaining to nose-cone and warhead design, development, and production.

In recent NACA tests at Wallops Island, Va., a scale model of what may evolve into an ICBM design was revealed. The standard streamlined cone has been replaced by a blunt ogival nose while a flared-out aft section replaces conventional fins. The flared aft section—unlike standard boattails—permits the use of swivel-mounted rocket motors for low-speed launching stability.

(*Continued on p. 676*)

STRENGTH

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Guided Missiles (Contd.)

New addition to our air-to-air missile family is the Navy *Sidewinder* missile. The missile was developed at the Naval Ordnance Test Station, China Lake, Calif., and is in production by Philco Corporation. *Sidewinder* is longer than a man, can be handled by two men, and is to arm all fleet aircraft. The guidance is said to be based on an infrared or heat-seeker system. Not relying on radar information, the missile will follow a heat source (in this case, the heat radiation emitted by an aircraft engine) and cannot be jammed. (See photo on page 622).

Air Force spokesmen in Detroit recently stated that they would also have a heat-seeker (nuclear-armed) in operation soon. Although not specifically named, reference was probably being made to the *Ding-Dong* missile which has received atomic warhead tests at our atomic test site in Nevada. One such atomic-armed missile is said to be able to destroy an entire attacking air fleet.

However, the heat-seeker system does not differentiate between friend or foe like radar-seeking *Falcon* GAR-1 air-to-air missile. The GAR-1 is new being placed in operation on the F-89H jet interceptor. Each wingtip pod carries three *Falcon's* plus twenty-one *Mighty Mouse* rockets.

Another air-to-air missile, the Navy *Sparrow* is being placed in operation on Canadian jet interceptors. *Sparrow,* also radar guided, is in operational use on Navy jets.

Elsewhere, Northern Ordnance of Minneapolis has been awarded a $23 million contract to produce launching equipment for the Navy ground-to-air missile, *Terrier,* which is fast becoming a standard shipboard antiaircraft weapon.

Longer-ranged *Nike B* may be nearing operational status. However, the ramjet-propelled *Talos* antiaircraft missile is said to be about as effective and nearer production status. Meanwhile, the far-striking Air Force *Bomarc* F-99 pilotless interceptor missile is nearing production.

Small-scale versions of two Army Ordnance rockets have received tests. *Baby Sergeant* is said to have been fired from atop a *Redstone* missile in recent tests in Florida. *Little John,* about 12 feet long, with a diameter of 12½ inches, was fired publicly at the A.O.A. meeting at Aberdeen in October.

Research Rockets.—An entire series of rockets has appeared on the research scene. Most are new or off-the-shelf solid-propellant rockets. They are intended for upper-atmosphere or ballistic research.

Arcon is a single-stage solid-propellant rocket designed to reach an altitude of 60 to 70 miles. Atlantic Research Corporation, Alexandria, Va., is designing the 12-foot long, 6-inch-diameter vehicle for the Naval Research Laboratory.

Iris, also by Atlantic Research, is designed to carry a 100-pound payload to an altitude of 200 miles. To be ready for delivery by 1958, the rocket is also powered by a solid-fuel power plant and is 13 feet long with a 12-inch diameter.

Nike-Cajun is being used by NACA to carry 40 pounds of instruments to 100 miles above the earth. The combination has already hit a speed of Mach 6.

Terrapin is the newest research rocket which is a joint development of the University of Maryland and Republic Aviation. At Wallops Island, Va., the *Terrapin* recently reached an altitude of 80 miles and a speed of 3,800 miles an hour. The 2-stage rocket weighs 224 pounds loaded and carries 6 pounds of instruments. It has a diameter of 6½ inches and is about 15 feet long. A third stage, now being designed, will enable an altitude of 200 miles to be reached in tests in 1957.

Triton, developed by the Applied Physics Laboratory of Johns Hopkins University for the Navy, tips the scale at about 20,000 pounds, has a length of 45 feet, and a diameter of 5 feet. Design speed is Mach 2.5.

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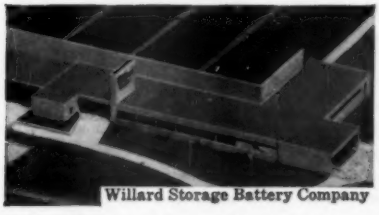

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Book REVIEWS

Reviews in this issue by:

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

COL. LEO A. CODD, *editor of* ORDNANCE, *Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

COL. CHARLES MCKNIGHT, *U.S.A. (Ret.), ordnance engineer, metallurgist, historian, and former company executive, Fork, Md.*

CHARLES G. METTLER, *artillerist, former Army Ordnance arsenal and depot commander and U. S. military attaché abroad, Miami Beach, Fla.*

LIEUT. COL. S. M. SMOLENSKY, *engineer, Ordnance officer, Washington, D. C.*

CAPT. J. M. P. WRIGHT, *U.S.N. (Ret.), naval ordnance engineer, logistician, editor, Washington, D. C.*

My Forty Years with Ford. By Charles E. Sorensen. New York: W. W. Norton & Company. 334 pp. $5.

AT long last, Charlie Sorensen, the man closest to Henry Ford during the building of the Ford empire and the man who lasted longest among the many who contributed to the success of the Ford organization, speaks his piece. It is a revealing picture of the trials and the experiments by which Henry Ford came to realize his scheme for the making of a motor car for the common man—a picture of his financial affairs as the millions rolled in and were spent to make more cars for the millions.

It is a picture, too, of the confident march of Henry Ford toward his goal in spite of the Selden patent and other obstructions that beset him and of his victorious conquest of the difficult task he had set for himself and his men.

Charlie Sorensen gives us a clear picture of the slow development of the moving assembly line that had to be perfected to get production costs down and of the purchase of mines and quarries for raw materials.

He shows us what happened when other men would not meet the Ford costs—the construction of a canal and turning basin, the rebuilding of a railroad to bring in supplies and take out products, and the construction of a new type steel plant.

When World War II strained the economy of every country, automobile production had to be suspended for the making of munitions, though Henry Ford did not like it at all. He was still the man of peace, who had sent the Peace Ship to Europe in World War I.

The best part of the book is the picture of Henry Ford behind the closed door of the shop, making the Model T, with Charlie running in and out with the wooden models of Ford's ideas until Henry had produced in final form the car of his dreams. Then, with the design in hand, came the processing of the design for mass production, the construction of the shop for

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For the Ordnance officer, or indeed for any one concerned with the production of armament, this book is a must, not only for the inspiration it offers but also for the solutions to problems of speed and cost that mean so much to the defense of our country.—CHARLES G. METTLER.

The Sound of the Guns. The Story of American Artillery from the Ancient and Honorable Company to the Atom Cannon and Guided Missile. By Fairfax Downey. New York: David McKay Company. 337 pp. $5.50.

THE author of a dozen books of history and adventure has now given us a thoroughly competent and highly interesting story of our artillery, from the 1745 siege of Louisburg, through Korea, and into today and tomorrow. While the work is not written as a textbook, it is strictly chronological and is far more than just a compilation of incidents and adventures. It is distinctly of the modern school of historical writing.

Downey's style is brisk and never slackens throughout the volume; yet it is documented by 265 well-chosen notes. The history is good save for a very few slips, such as the attribution of Burgoyne's pack guns of 1777 to Sir William Congreve, then five years of age. Describing the Battle(s) of New Orleans, muffed by nearly every historian, he does give credit to the splendid American artillery, yet still is influenced by the legend of "deadly rifle fire."

The volume does not, of course, purport to be a technical ordnance work. Yet the details of artillery, ammunition, and use are far superior to any parallel service history that this reviewer has seen. The final chapter is devoted to an excellent description (as far as security classifications permit) of current developments and future trends in artillery and ammunition. All told, "The Sound of the Guns" is a work that will surely delight all who have an interest in our military history, our weapons, and our defense.—F. W. FOSTER GLEASON.

National Standards in a Modern Economy. By Dickson Reck. New York: Harper & Brothers. 372 pp. $5.

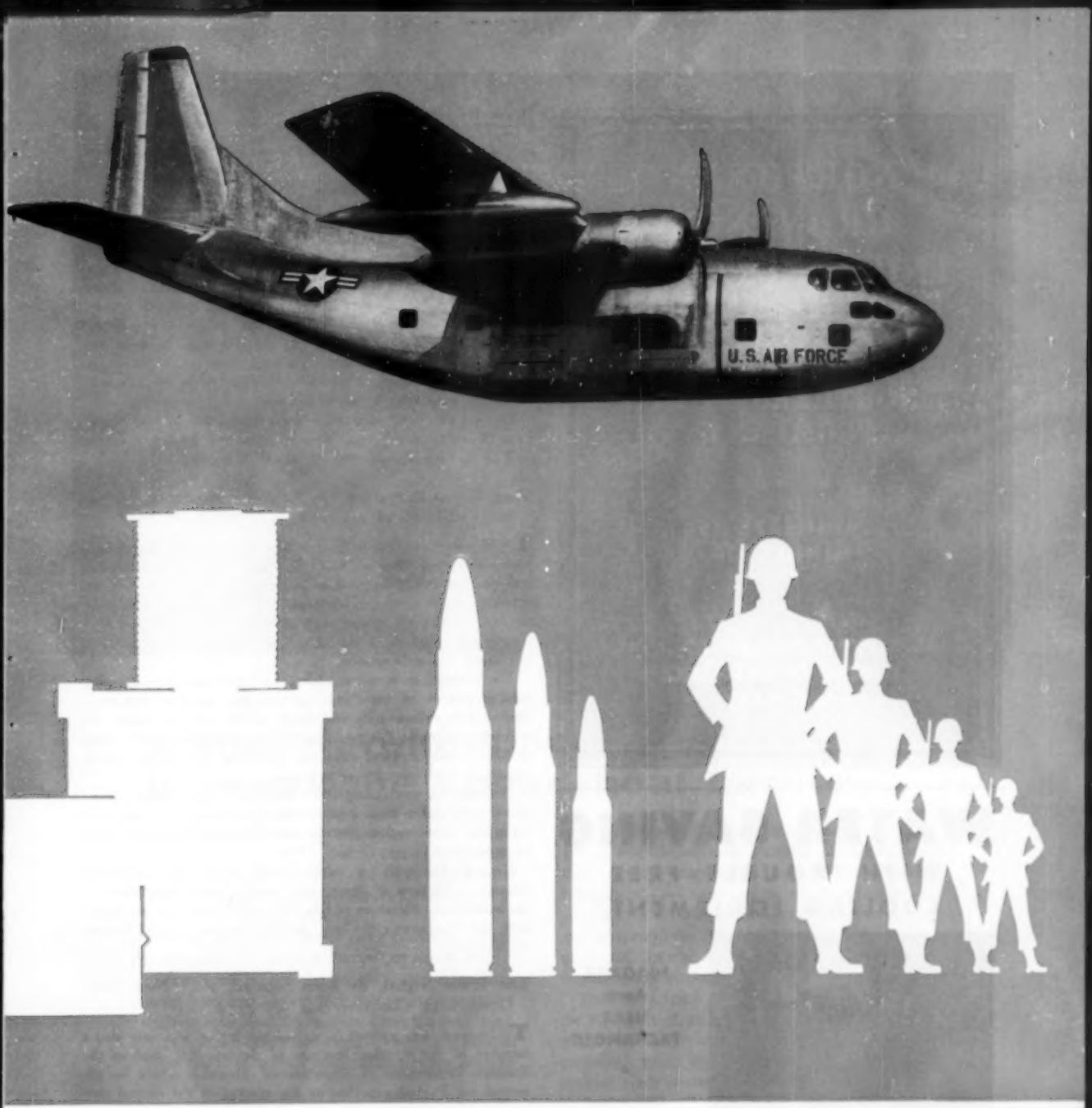
HERE is the record of the status of standards in the United States as of the middle period of the twentieth century. Thirty-four specialists review the standards that link the achievements of scientific research with technological innovation and high production efficiency in the age of automation.

Many of the contributors to this volume are leaders in the private and public organizations that have developed modern standards. For example, there is a very thought-provoking essay on the "Significance of the National Bureau of Standards for Industrial Progress" by its distinguished director, Dr. A. V. Astin.

This book was chosen by the editors of ORDNANCE as the Association's Book of the Month for December 1956. Many members will read it with profit for themselves and their organizations—commercial, scientific, and governmental.—LEO A. CODD.

Through Hell and Deep Water. By C. A. Lockwood and H. C. Adamson. New York: Greenberg Publisher. 317 pp. $4.50.

A gripping biography of a famous submarine commander and his submarine, the HARDER. Comdr. Sam Dealey was a quiet Texan who rose to magnificent heights of achievement and



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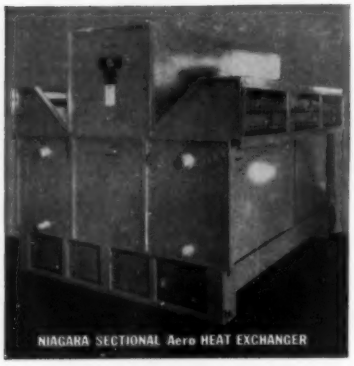

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Book Reviews (Contd.)

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The authors have included a good description of the World War II submariner and an intimate account of the life of a submarine on long war patrols.—J. M. P. WRIGHT.

They Met at Gettysburg. By Edward J. Stackpole. Harrisburg: Eagle Books. 342 pp. $4.95.

THIS recent addition to the swelling flood of Civil War literature will appeal alike to the Civil War Round Table enthusiast and the historically inclined general reader. It is, of course, an account of the campaign and battle of Gettysburg. It is good history—factual but spiced with opinion, detailed but not confusing, and accurate to the same degree as the sources, which are many and authoritative.

The author, as it were, shows an enormous, encompassing motion picture of marching, fighting men in blue and gray against the mellow hills and sharp ravines of Gettysburg. At times he fades out this background to emphasize in contrasting brilliance some critical event or important personality—be he important from strength or weakness.

The book is generously illustrated, but, unfortunately, many of the cuts suffer from modern cost limitations. The maps are numerous and excellent, but on some the type is so small as to be unreadable.

General Stackpole, a soldier who knows his Gettysburg through a lifetime of study, has made a real contribution to the voluminous literature of this battle. His book may not be the best, but it is among the best—and the best are few.—CHARLES MCKNIGHT.

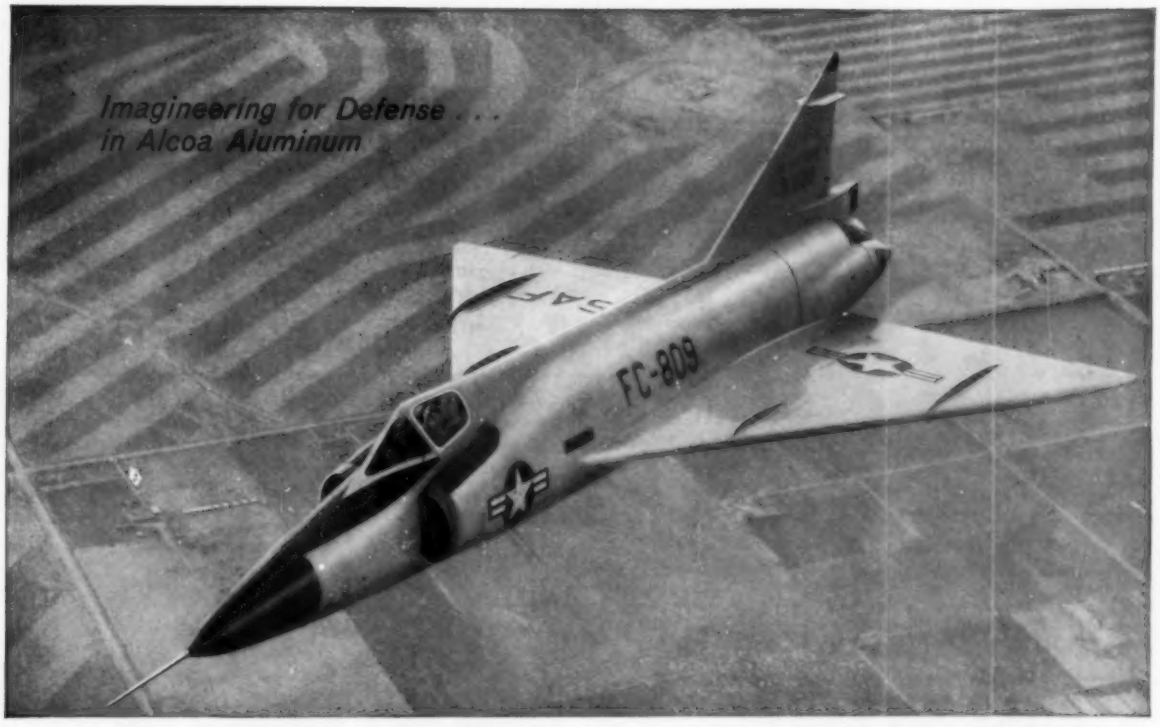
The White Nights. By Boris Sokoloff, M.D. New York: Devin-Adair Company. 294 pp. $3.75.

THIS book was written by a Russian doctor who was also a member of the Russian Institute of Science and head of the Russian Department of Experimental Medicine where he observed the Pavlov experiments for control of the central nervous system by a technique that induced a state of extreme neurosis, later used by the Communists to condition prisoners for court trials.

After his escape from Russia he was connected with the Pasteur Institute in Paris and with the Rockefeller Institute for Medical Research. His book is based on a notebook he kept during the tumultuous period of the Kerensky Government and the rise to power of the Soviets. It is an analysis of the character and methods of the Communists rather than an historical summary.

Like others who have escaped to the West from Communist Russia, the author is amazed at the naïveté of Western diplomats and politicians in believing that they can live with Marxian Communism by appeasement and compromise, since it has been proved over and over that every appeasement is a defeat and that the Communists never compromise except when it means an advantage to their long-term aims.

The author believes that the American conception that Com-



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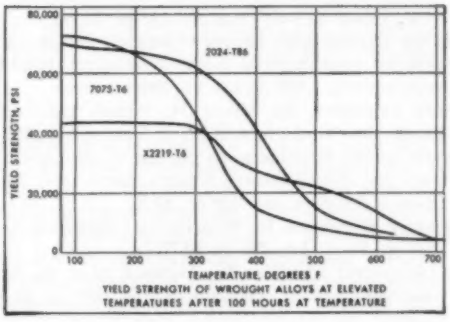

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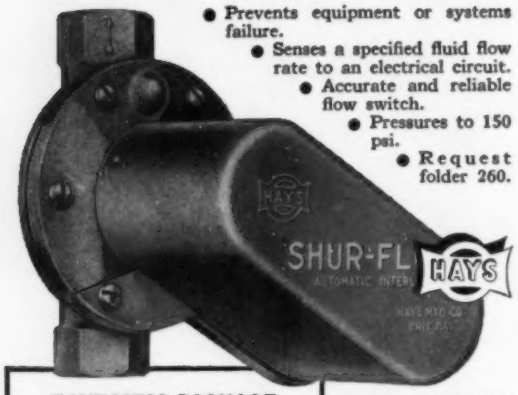

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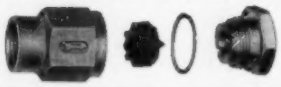

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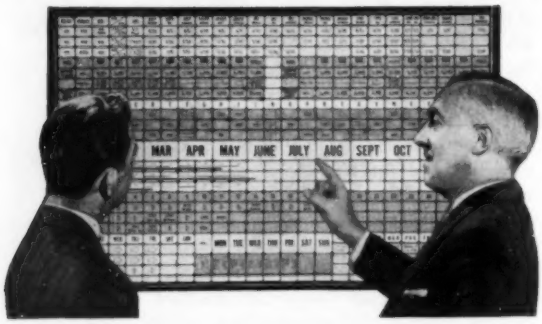

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Book Reviews (Contd.)

munism grows out of bad economic conditions and can be eradicated by raising living standards is erroneous thinking. Every Communist victory has been accomplished with the help of intellectuals and fellow-travelers, and it is through the intellectuals that Moscow now seeks to destroy our democracy. Lenin had a vast contempt for the intellectuals he used to forward his conspiracies. He wrote: "We must use them, but never should we enter into union with them."—GEORGE S. BRADY.

Men in Arms. By R. A. Preston, S. F. Wise, and H. O. Werner. New York: Frederick Praeger, Inc. 376 pp. $6.50.

THE current international display of interest in the pros and cons of H-bomb testing dramatically points up the keen interest and concern of all humanity in problems of warfare.

Without taking an apocalyptical approach, but realizing the threat that warfare imposes to civilization, the authors, in tracing its history, have tried to make clear its influence in modern society, thus providing the reader with a background to help him answer the riddles of the future.—STANLEY SMOLENSKY.

BOOKS RECEIVED

The Age of Fighting Sail: The Story of the Naval War of 1812. By C. S. Forester. New York: Doubleday & Company. 284 pp. $5.

Calculus: Refresher for Technical Men. By A. A. Klaf. New York: Dover Publications, Inc. 431 pp. $1.95 (paper bound).

Engineering Inspection Measurement and Testing. By H. C. Town and R. Colebourne. New York: Philosophical Library. 192 pp. $8.75.

The Fabulous Future: America in 1980. As seen by David Sarnoff, John von Neumann, George Meany, Nathan M. Pusey, Earl Warren, Crawford H. Greenewalt, George M. Humphrey, Adlai E. Stevenson, Robert E. Sherwood, Charles P. Taft, Henry R. Luce. New York: E. P. Dutton & Company. 206 pp. $3.50.

The Fatal Decision. General of the Air Force Werner Kreipe, Gen. Gunther Blumentritt, Lieut. Gen. Fritz Bayerlein, Col. Gen. Kurt Seitzler, Lieut. Gen. Bodo Zimmerman, Gen. Hasso von Manteuffel. Edited by Seymour Freidin and William Richardson. Translated from the German by Constantine Fitzgibbon. New York: William Sloane Associates. 302 pp. $4.

Government Contracting in Atomic Energy. By Richard A. Tybout. Ann Arbor: University of Michigan Press. 226 pp. $4.50.

Histories of American Army Units: World Wars I and II and Korean Conflict. Compiled by C. E. Dornbusch. Washington, D. C.: Department of the Army. 310 pp. $1.10 (paper bound).

The Men Behind the Space Rockets. By Heinz Gartmann. Translated by Eustace Wareing and Michael Glenny. New York: David McKay Company. 185 pp. $3.95.

Quality Control and Applied Statistics. An abstract service published monthly. New York: Interscience Publishers, Inc. Approximately 1,000 pp. per vol. $60 per year.

Radio Telemetry. By Myron H. Nichols and Lawrence L. Rauch. New York: John Wiley & Sons. 461 pp. $12.

Report on the Helicopter. By Samuel C. Williams. Brundage, Story and Rose Research Reports, Series A-1. Ann Arbor: Edwards Brothers, Inc. 220 pp. $2.50.

Speaking of Politics. By Franklin Cary Salisbury. New York: Vantage Press, Inc. 294 pp. $3.75.

Trigonometry: Refresher for Technical Men. By A. A. Klaf. New York: Dover Publications, Inc. 629 pp. $1.95 (paper bound).

Zoomies, Subs, and Zeros. By Vice Adm. Charles A. Lockwood, U.S.N., Ret. New York: Greenberg Publisher. 301 pp. $3.95.

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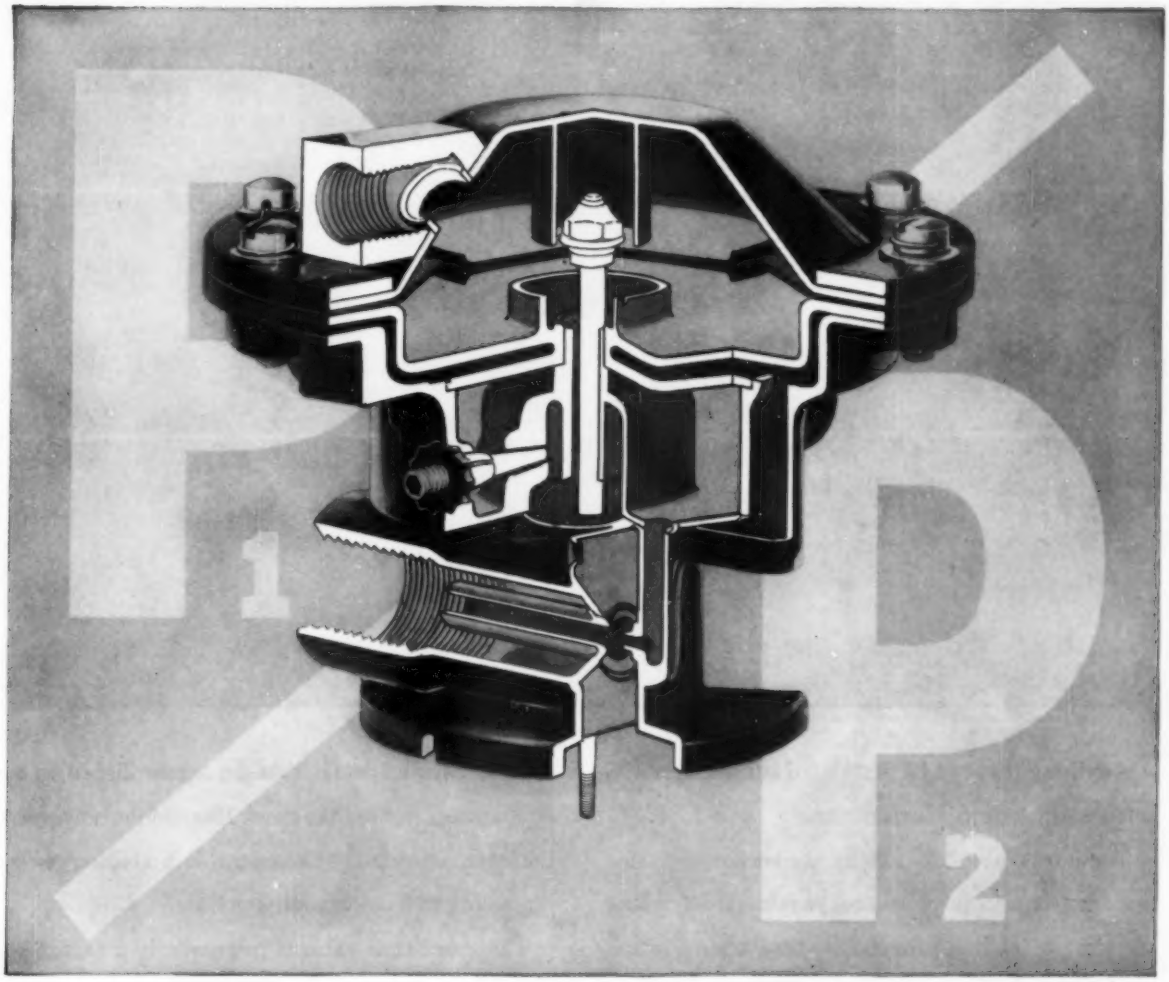

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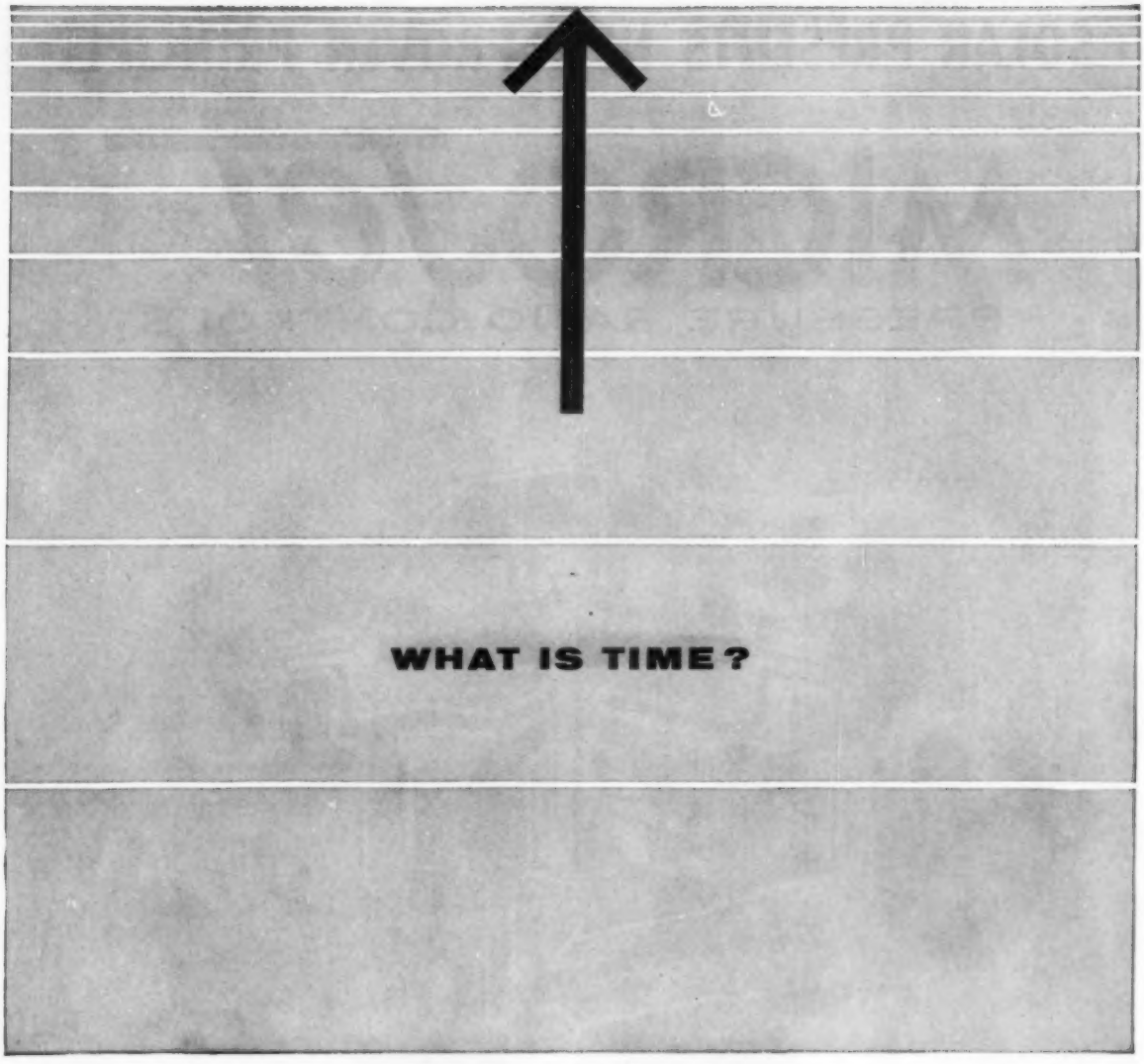

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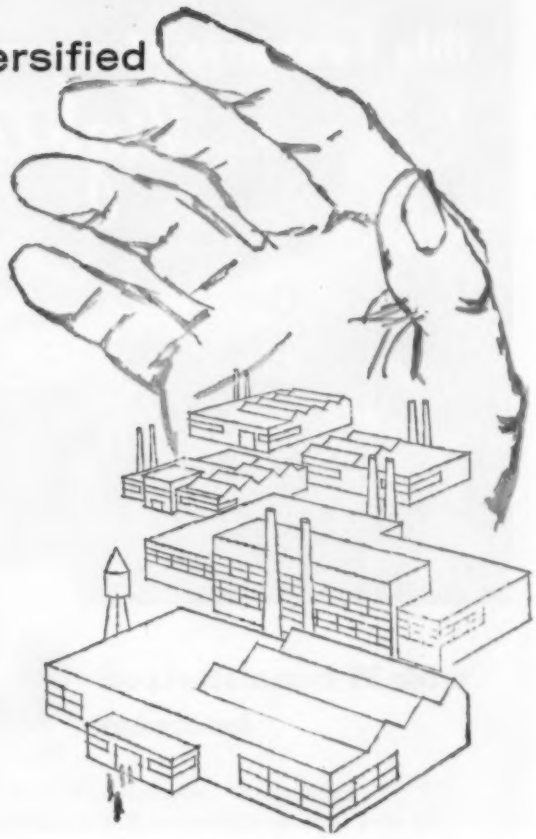

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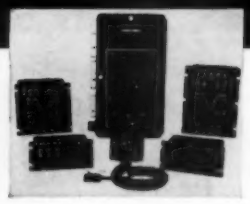

TI PRODUCTION ENGINEERING helped Lockheed trim 55 lb of dead load from the P2V-7 sub-hunting Neptune . . . by transistorizing just one system — the 14-station intercom. In addition to saving weight, safety and reliability were *increased* while maintenance and power drain were *reduced*.

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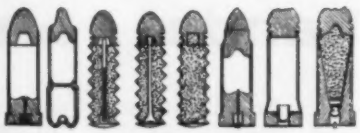

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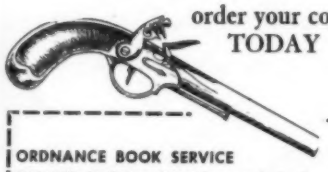

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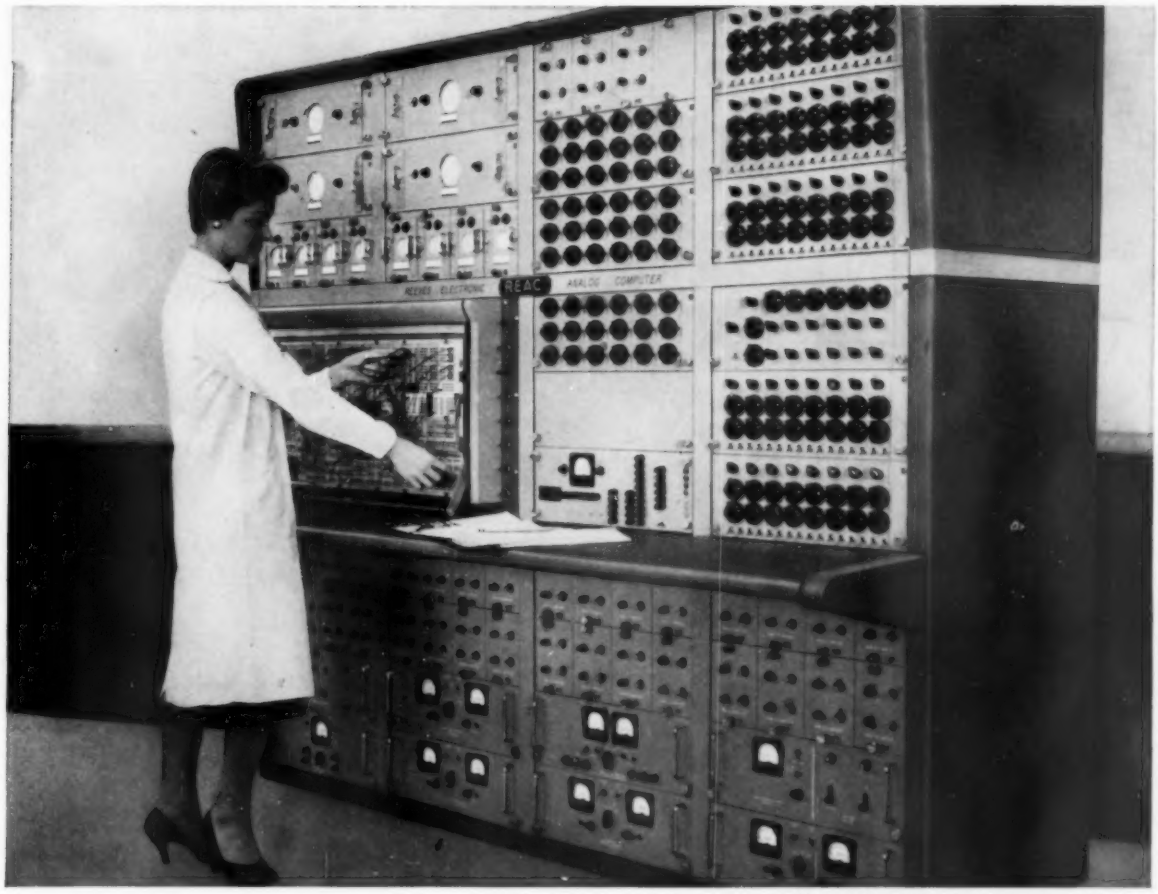

Photo courtesy of Dynamics Corporation of America

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Beryllium copper Phosphor bronze	Beryllium copper is used because it provides excellent elastic and fatigue properties when heat-treated; phosphor bronze because of its exceptional spring qualities and resistance to wear. Both have properties which make them ideal for the 11,000 essential spring contacts. Torsion bars, clips, probes, and shafts also use these copper alloys.
Aluminum bronze Manganese bronze Naval brass	Used for gears, bearings, bushings, clamps, and structural parts.
Brass	Used for screw machine products, gears, hardware, fittings, springs, pins, and wherever soldering or brazing must be done.

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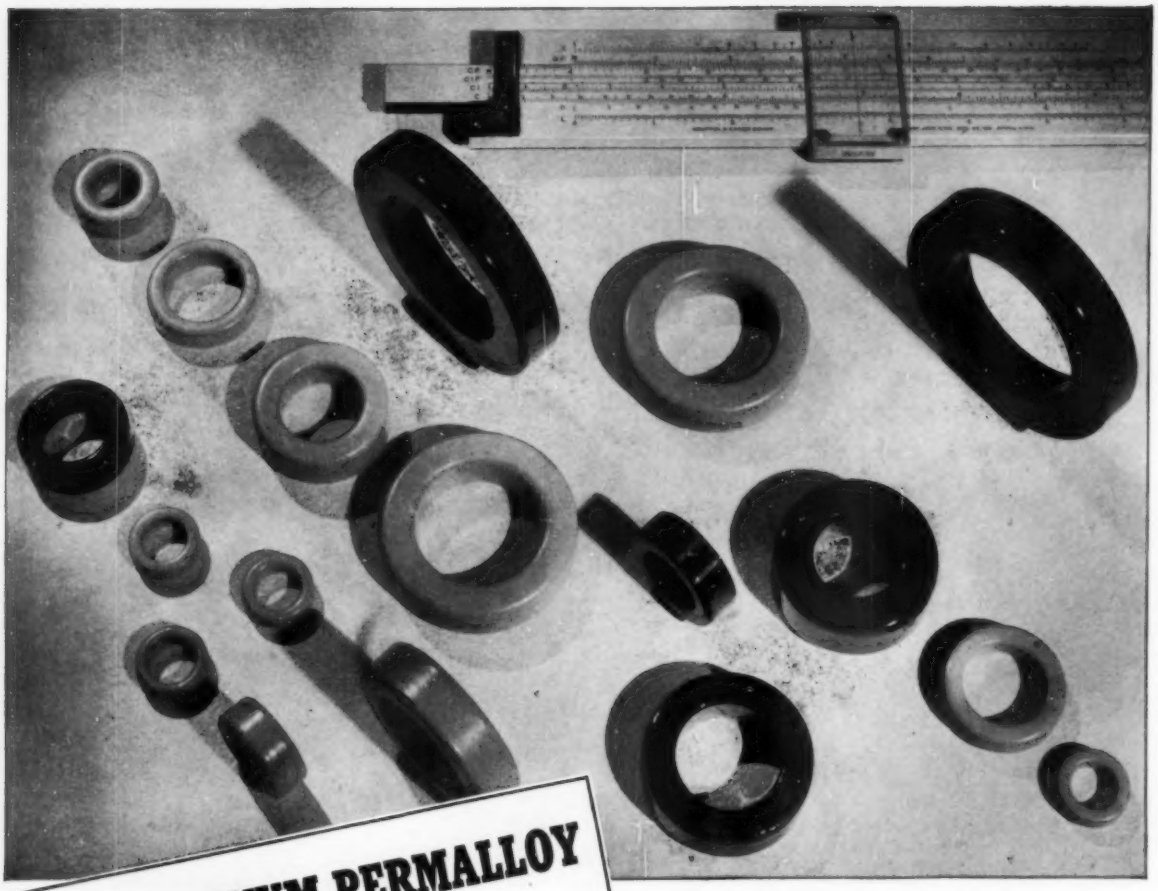

MOLYBDENUM PERMALLOY POWDER CORES

(New technical data now available)
Write for Bulletin PC-104B, dated October, 1956

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For Bulletin—ADDRESS DEPT. O-71

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Items range from missile launchers and missile propellant chambers to weldments and springs; ALCO is also prime contractor for tanks and atomic power plant

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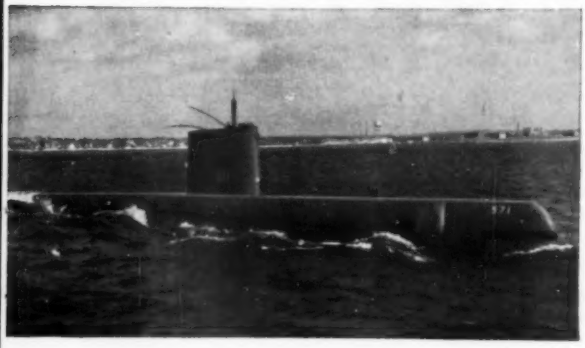

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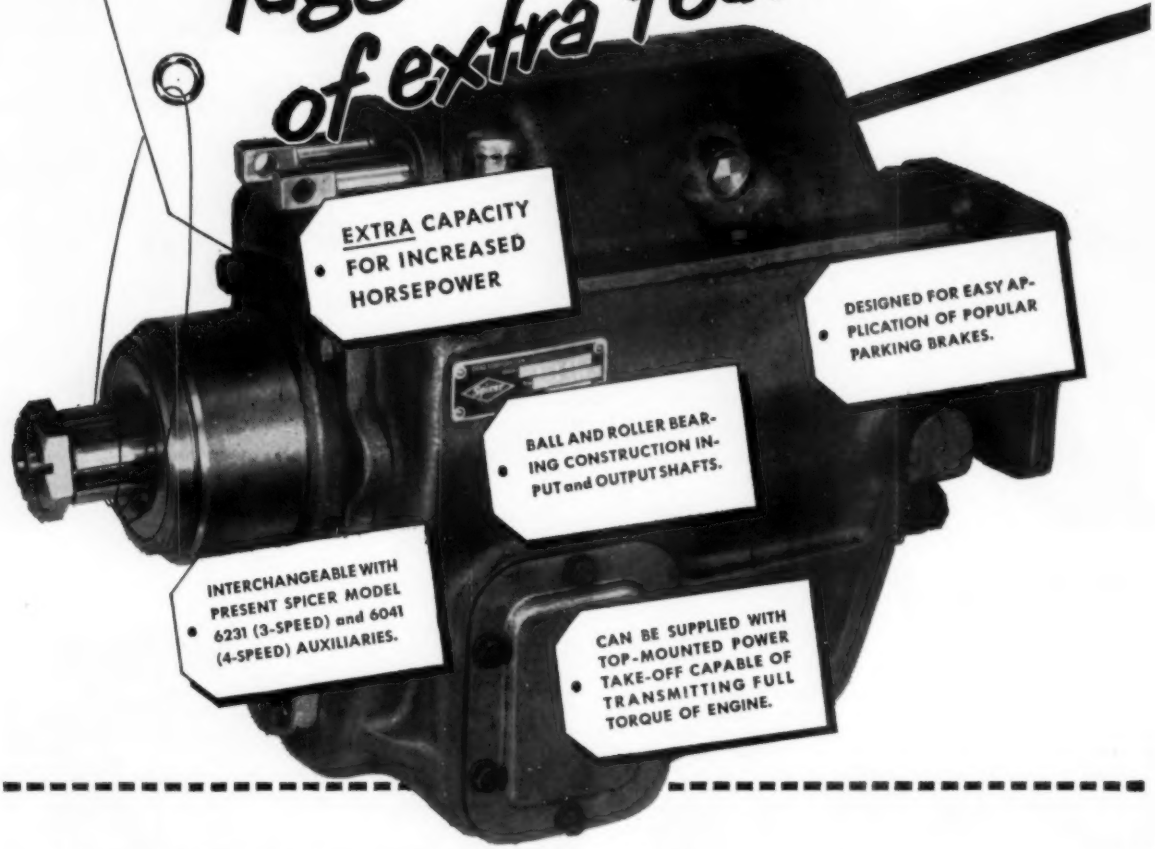
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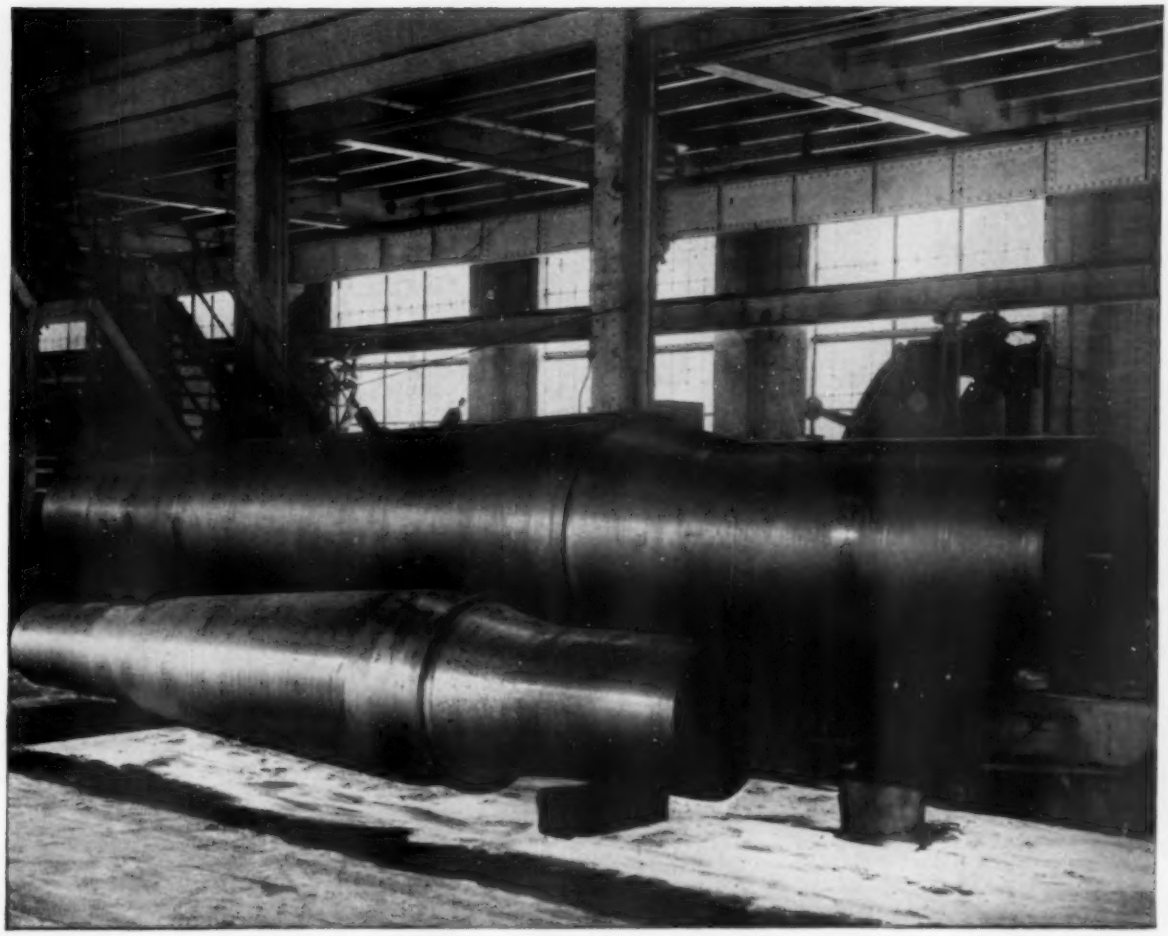

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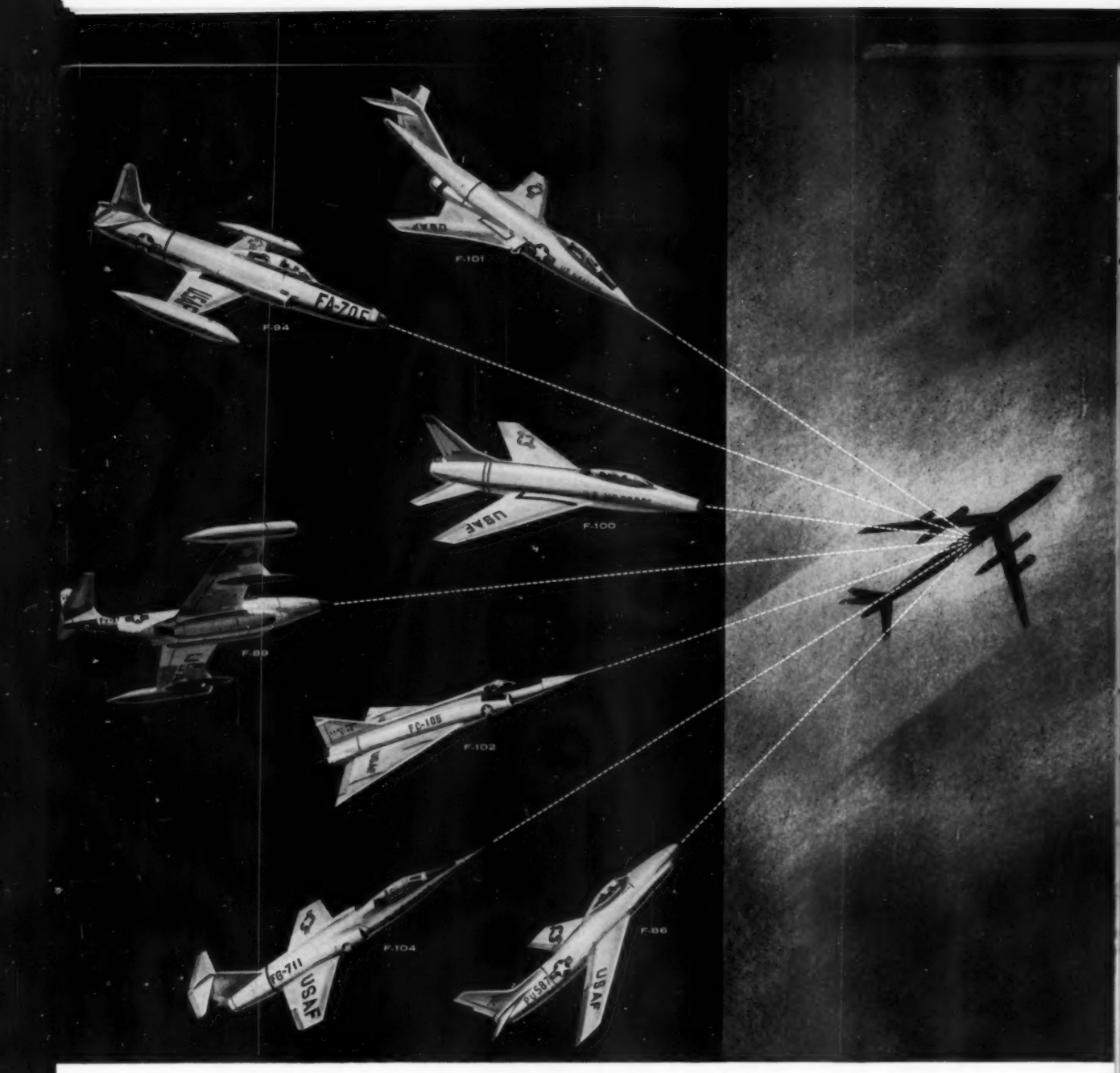

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Cooper Alloy Corporation's new plant in Clark, New Jersey, is now at full capacity rolling rings for jet aircraft. Loewy-Hydropress designed the plant, chose the site, supervised construction, specified, procured and installed all machinery and started up operation. So successful were the results that Cooper Alloy has retained Loewy to construct an addition to the plant.

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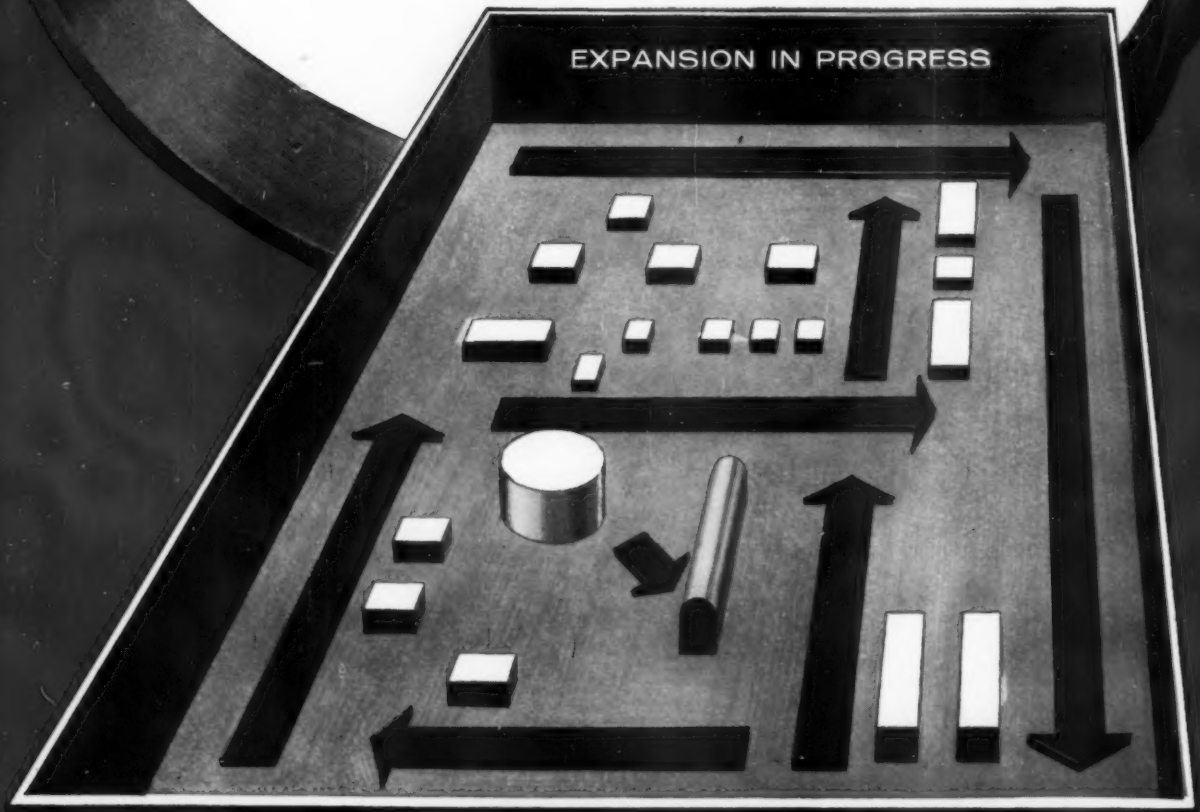

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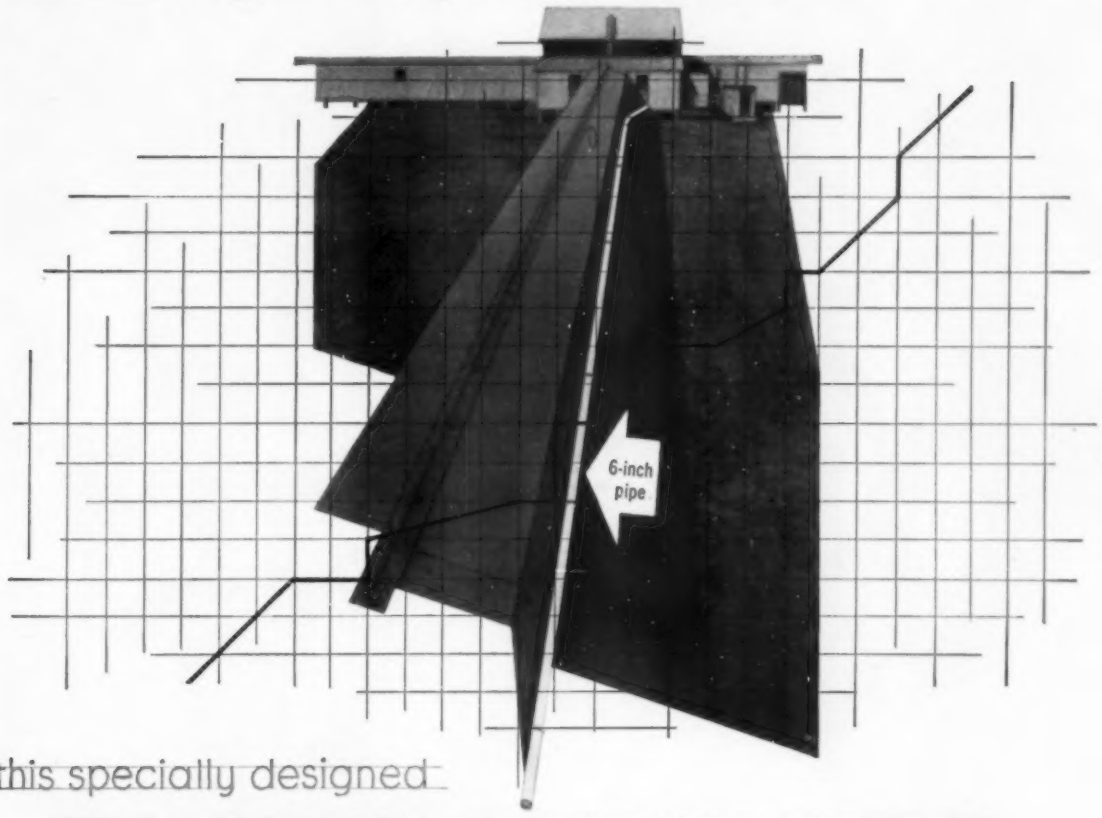
DIVISIONS: Austin-Western • Eddystone • Hamilton • Electronics & Instrumentation • Lima • Madsen • Loewy-Hydropress • Pelton • Standard Steel Works

Hoffman engineered systems get **results:**



this specially designed

HOFFMAN PNEUMATIC CONVEYING SYSTEM

improved safety and cut costs in transporting **TNT!**

In this arsenal TNT has to be taken from the box-opening and screening building to another building approximately 500 feet away for melting.

The old system: A powered screen discharged TNT into wheeled buggies that were pushed by hand along the 8-foot enclosed ramp shown above. At the other end, each buggy was taken up to the third floor, in one of two freight elevators, and the TNT was fed to the melting equipment.

The new system: TNT is conveyed directly from screening to melting through a 6-inch pipe, at a rate up to 200 pounds per minute, although no more than one 50-pound increment is being conveyed through the pipe at any given time. No handling. No buggies. No elevators.

Results: (1) Hoffman furnished a double damper valve that handles the TNT safely and automatically meters its flow. (2) The control of the interrupted stream of conveyed explosives maintains the safe separation of different operations. (3) The pneumatic system paid for itself in the first 18-months' labor saving.

In new construction, the elimination of the ramp and freight elevators would more than pay for the pneumatic conveyor, disregarding the labor savings involved. This is usually the case, comparing Hoffman pneumatic systems with other material handling methods.

Consider how much **you** can save moving material pneumatically. Your letter will bring more information or the services of a trained representative, without cost or obligation.

ORDNANCE EQUIPMENT DIVISION **U.S.HOFFMAN MACHINERY CORPORATION** DEPT. ORD., 103 FOURTH AVENUE, N.Y. 3, N.Y.

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project
VANGUARD
poses a
problem . . .
$V = \int_0^t a\,dt$
provide a
CONTINUOUS SOLUTION
to this time integral . . .
. . . and REEVES comes up with the solution
Placing the earth's satellite in its pre-determined orbit requires precision to the nth degree. The second-stage of the three-stage rocket which will carry the satellite up to its orbit must be separated shortly before its trajectory bends back towards the earth.
Separation of the second stage is controlled by a coasting time computer designed and built for the Martin Company of Baltimore by Air Associates, Incorporated.
The Reeves Instrument Corporation has designed and is building for Air Associates the "speedometer" needed for computing the second-stage coasting time as a function of the burn-out speed. Essentially an integrating accelerometer, it provides a continuous record of velocity as the rocket speed builds up and feeds this information into the control unit's computer.
The control unit, after the computed coasting time has elapsed, triggers the system. Stage two is separated and stage three gives the satellite the final acceleration required for insuring that the satellite circles around the earth.
Because of its vast experience in design of precision gyros and accelerometers, Reeves has been assigned the task of developing an important instrument for use in one of man's great ventures, Project VANGUARD.
Reeves
INSTRUMENT CORPORATION
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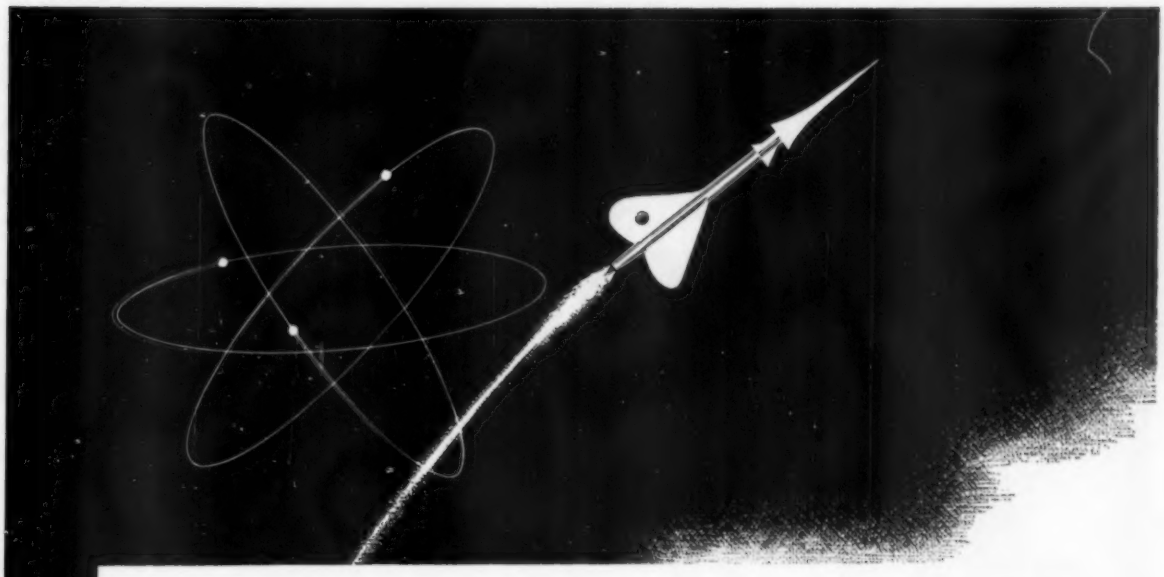
REEVES INSTRUMENT CORP. A SUBSIDIARY OF DYNAMICS CORP. OF AMERICA, 215 East 91st St., New York 28, N. Y.



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They used to remove a section of the deck to get a radar switchboard inside a submarine. Now it fits easily through a hatch because Admiral has redesigned the unit to reduce bulk and weight by as much as two-thirds!

This priceless saving in pounds and inches is only one of the new unit's many advantages. Formerly up to 400 man-*hours* were needed for major repairs such as replacing a defective switch section. Now the job is done in 20 *minutes!* The entire unit is built up of standardized sub-assemblies fitted with multiple connector plugs. It is a simple matter to remove and replace a faulty switch or amplifier. Each switch section even has its individual power supply to keep the switchboard operable in case one section goes out. The unit can be readily expanded to handle additional radar indicators by simply adding more self-contained sections. Printed switches and circuit boards, designed for automation assembly, are ruggedly resistant to vibration and humidity.

The radar switchboard, for use on all types of naval vessels, is typical of Admiral's advanced design, research and development in electronics, now being carried forward for all branches of the Armed Services.

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"Operation Facelift" is underway – speeding today's byways into tomorrow's highways. And, pitting giant muscles against this tremendous task is the newest road-building equipment. For modern machines are the key to modern roads.

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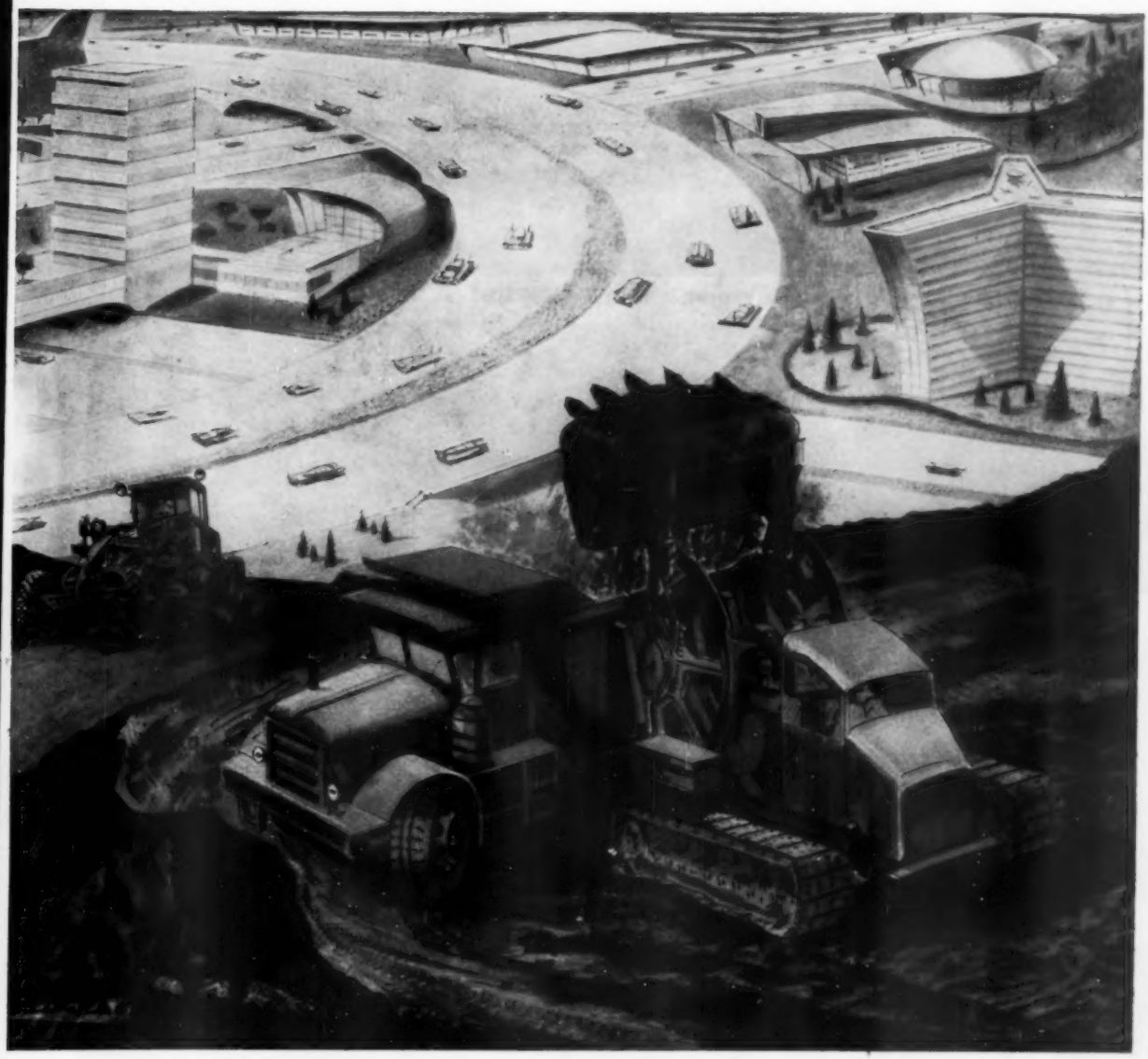

byways into highways

TORQMATIC DRIVE. You'll see many of them on display at the ARBA Show in Chicago. And, we'll be looking for you at the Allison TORQMATIC Display, too, where we'll show you how TORQMATIC DRIVES can give your equipment *new utility—new efficiency—new economy*. For further information, write: Allison, Division of General Motors, Box 894W, Indianapolis, Indiana.

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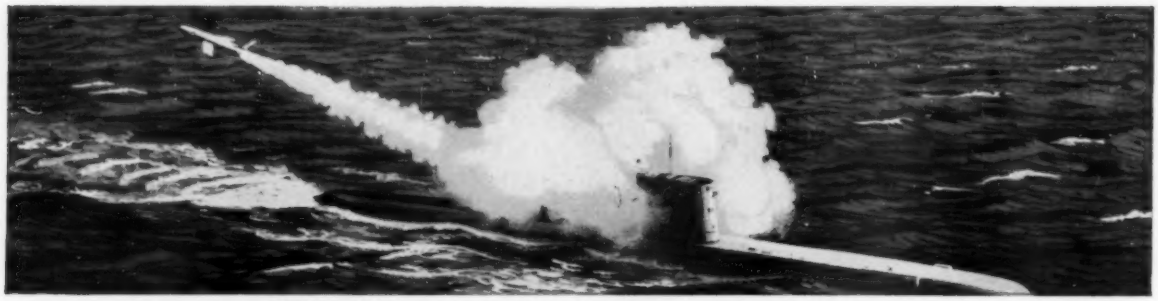
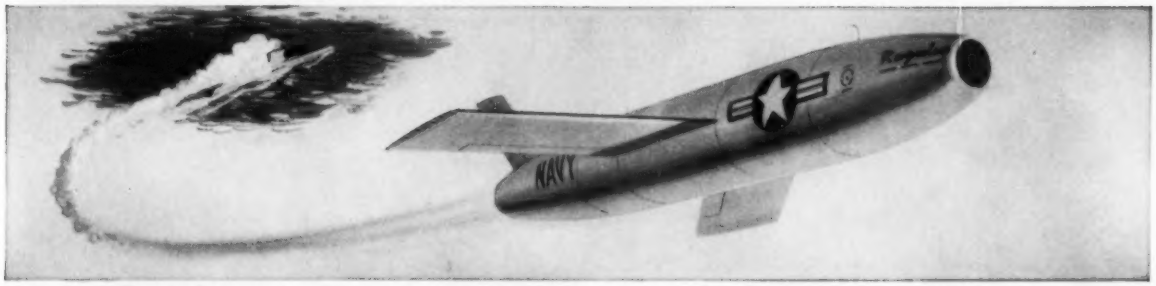
1 Submarine surfaces near enemy coast...



2 ...launches *Regulus* guided missile...



3 ...*Regulus* streaks toward target...

4 ...submarine dives, no trace remains.

Airborne Thunder for the Silent Service

Regulus guided missiles now make aircraft carriers out of Navy submarines. This new weapons team is typical of Navy's Nuclear Age tactical power. Carried invisibly to enemy shores, launched against a target far inland, *Regulus* gives your New Navy an *intercontinental capability today!* Designed and built by Chance Vought Aircraft, *Regulus* is a prime example of the dependability and accuracy that makes new Navy weapons and techniques increasingly important to a strong U. S. Defense Team.

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N-A-X FINEGRAIN is a low-alloy, high-strength steel with many diversified applications in modern metals design. Compared with carbon steel—

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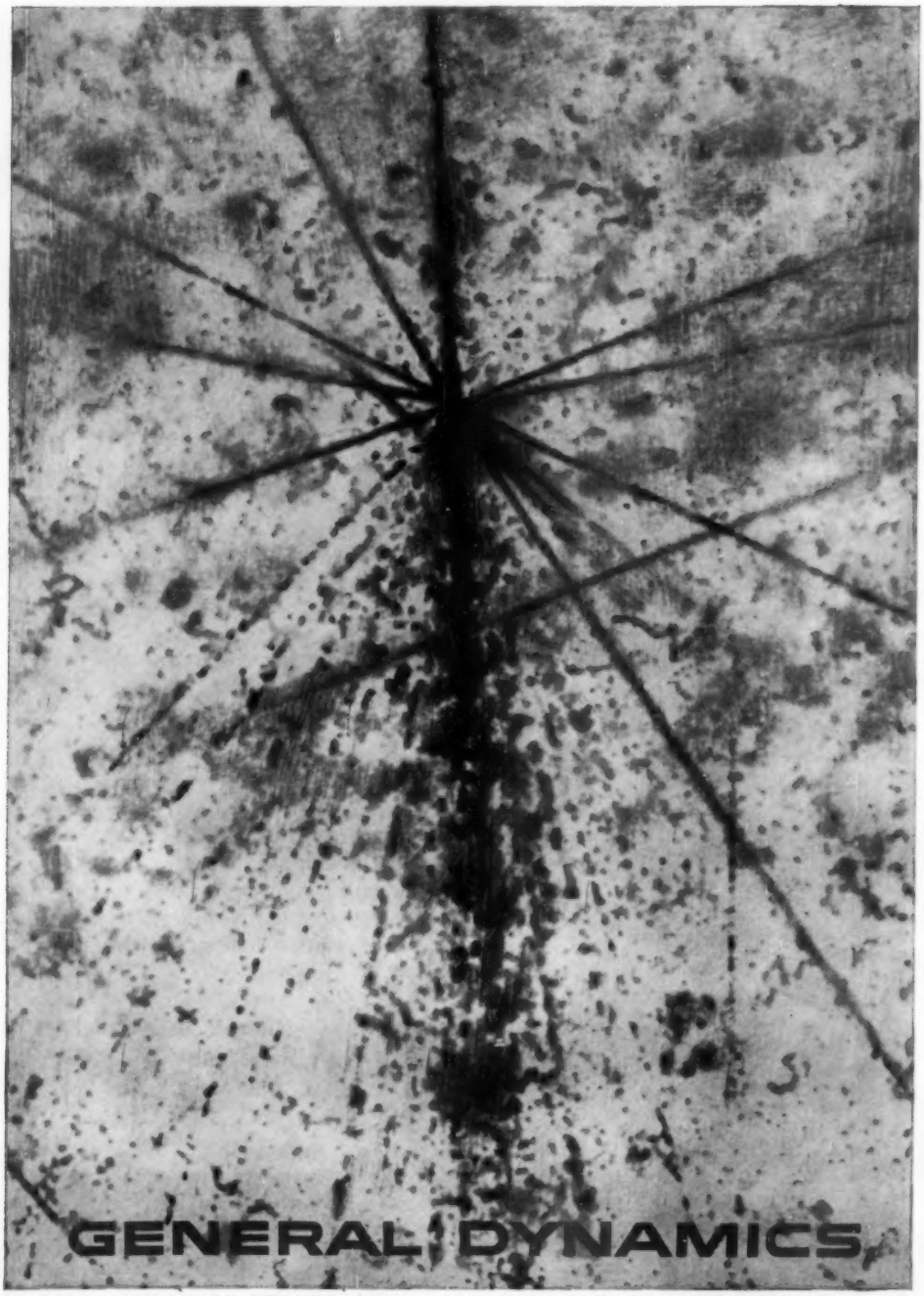
Exploring the Universe: Sub-Atomic Worlds.... To Greeks, the atom was literally "a-tomos," not to be cut. Now its very nucleus is split and scientists are tracking *sub-atomic* particles, seeking to discover the nature—order and meaning—of a vast, dynamic universe in which domestic notions of space and time and energy do not apply. *Ethical corollary:* The "finds" of nuclear exploration must be employed *not* in the service of a scientific, or economic, or political provincialism but *wherever* they are needful to the physical, mental and moral rehabilitation of men and of societies.



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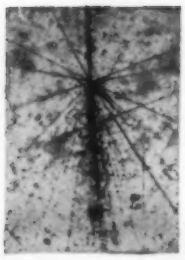


"Within the next century, all the world will be poor in energy ...except for atomic energy."

Can we say then—since there is a positive correlation between energy consumption and national income, and between national income and individual living standards—that many of today's children may see, and suffer from a world-wide poverty?

The industrial West—metallurgy, combustion engines, chemistry, steam, electricity, electronics—was built and is maintained by *power* derived from fossil fuels. It is a "coal and oil" civilization and it, alone, in the next century could consume all the free world's coal and oil resources.

Now, however, the once-agrarian East and Latin America—two-thirds of the world's population—also are determined to have the benefits of industrialization: *power* to conquer poverty and disease; *power* to create and maintain an economic self-sufficiency; and, out of that, *power* to create and maintain political freedom.

The practical developments of the Industrial Revolution that have so profoundly changed the world economy since 1856—the Bessemer converter, aniline dyes, oil-cracking, the internal combustion engine, the electric motor, electric light, electric power, synthetics, electric and electronic communication, automation and computation, the submarine, winged and wingless aircraft and the space rocket—were the direct result of preceding theoretical explorations by Galileo, Bacon, Newton, Gauss, Laplace, Faraday and those others who could visualize new worlds.

the view from 100 years

The Atomic Revolution now overthrowing present conceptions of power, transport, communication, medicine, agriculture and biology—and hence colonial and collectivist politics—stems directly from the pure and applied scientific research of Curie, Rutherford, Planck, Einstein, Bohr, Fermi, and hundreds of others.

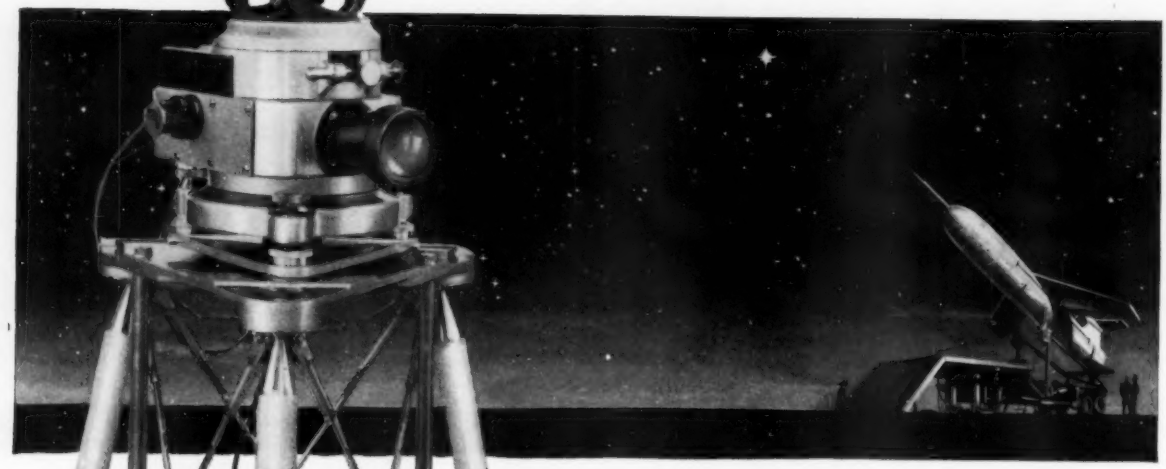
It is evident, then, that *exploration of the universe* is now requisite to our survival as men and nations.

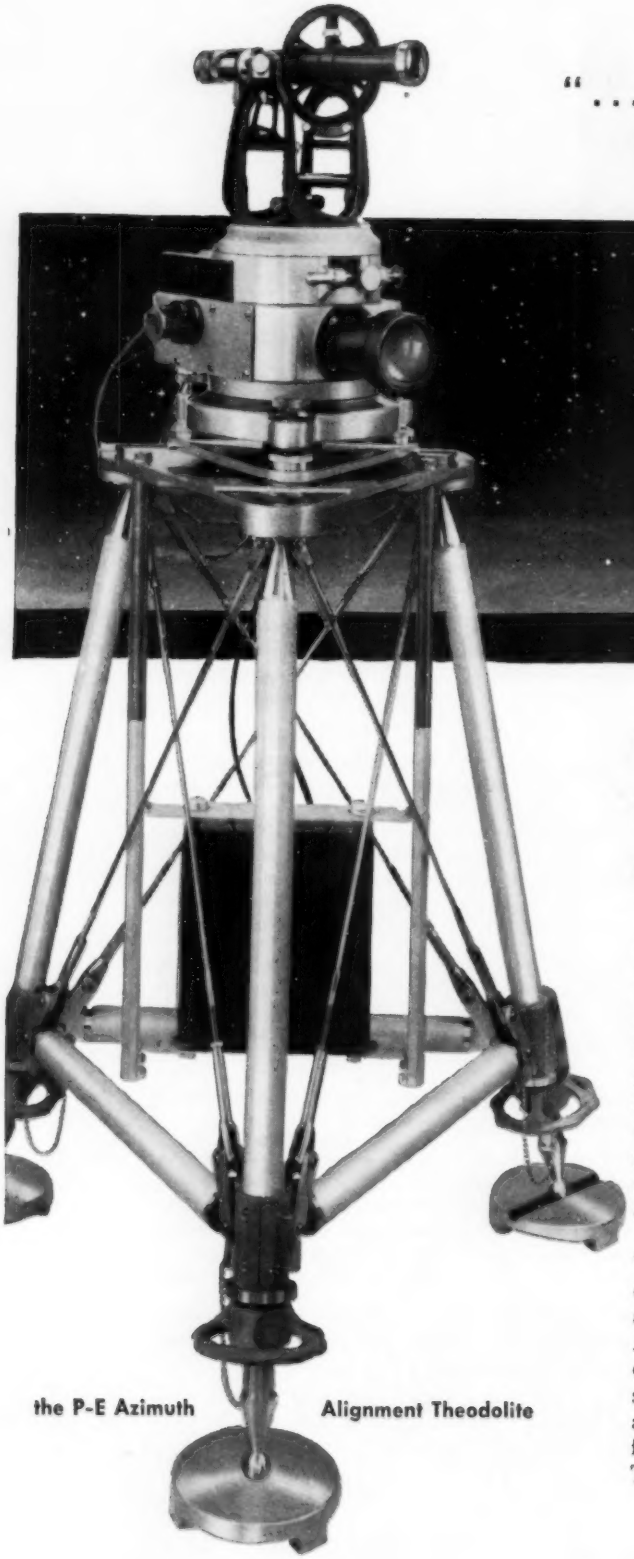
Thus, prospecting for new energy sources—whether in sub-atomic worlds, in the atom, in the earth, in the sea, in the sun, or in the dynamics of stars—is an enterprise for new *scientist-manager-engineer-share owner* groups. Corporate "systems" with the research and development capabilities, the production facilities, the financial capacity and the courage to fit out scientific expeditions to new and far places—and to capitalize on their discoveries.

General Dynamics today is the product not only of its own particular history but of the scientific and industrial history of the Western world. As such, Dynamics declares its corporate purpose to be:

The comprehensive exploration and translation of the basic forces of nature into useful work under the sea, on the sea, on land, in the air, and in space beyond the earth's atmosphere.

"...and a star
to steer her by."





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To give exact directional alignment to an automatic navigation system, the P-E Automatic Azimuth Alignment Monitoring Theodolite takes a "fix" on a navigational star and transfers the resulting angular data to the controlling mechanism. The accuracy of this astral bench mark to a great extent determines subsequent directional accuracy. *So precise is this instrument that it makes possible automatic alignment of the system to within a few seconds of arc under day or night conditions.*

Where extremely fine angular data must be established, the P-E Azimuth Theodolite offers a level of performance never previously available. Accuracy, as indicated by a "no correction" output of the monitored equipment, is ± 2 seconds of arc. Standard production models are available with working distances from 1 to 1500 feet. For further information on the Azimuth Theodolite, write to —

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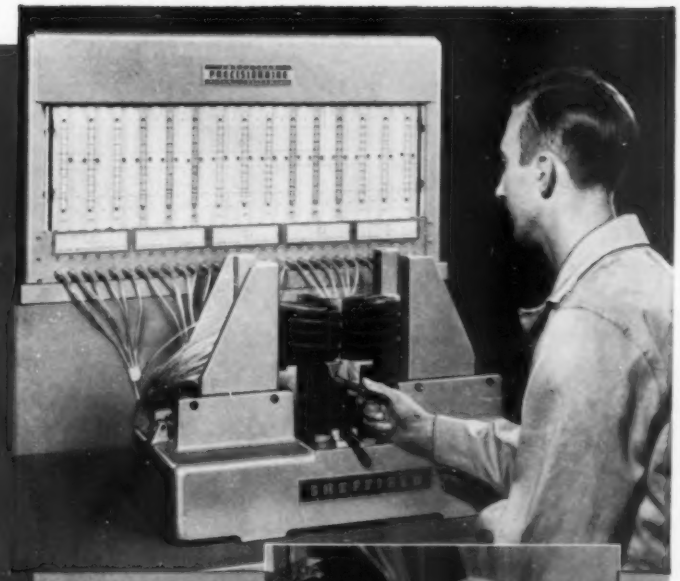

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3. The position of each float shows just where the dimension is within tolerance limits or just how much above or below limit if it is out of tolerance. This is essential for Quality Control.

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Lightweight structural metals with high strength, stiffness and elasticity at elevated temperatures! A new group of Dow magnesium alloys offers a great combination of these properties without the fabricating difficulties normally experienced with other high temperature materials.

Specially developed for use in airframes, missile and engine structures, the new alloys are already making weight reductions possible for several manufacturers. These alloys show advantages at temperatures up to 700°F. Limited test data on properties up to 800°F. are available for some of them.

FABRICATION: Fabrication characteristics are equal to those of standard magnesium alloys.

WELDABILITY: 95 to 100% weld efficiency at elevated temperatures.

FORMABILITY: Single deep draws can be easily accomplished.

MACHINABILITY: Best machining characteristics of any structural metal.

One of the new alloys is magnesium-thorium composition HK31A. It is now available in rolled form from stock. Castings and sheet in mill quantities are also readily available. A companion alloy for extruded shapes and forgings will soon be in production.

For more information about the new high temperature magnesium alloys, contact your nearest Dow Sales Office or write to THE DOW CHEMICAL COMPANY, Magnesium Sales Department MA 362N, Midland, Michigan.

EASILY FORMED. These HK31A parts were drawn using production dies and processes for standard magnesium alloys. The parts retained a higher percentage of original properties than standard alloys.

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Aerophysics HTV Rocket

probes the temperatures of Hypersonic Flight

Only speeds many times that of sound can supply the answers to today's vital questions about the "thermal thicket" where ordinary aircraft metals blister and disintegrate and ordinary windshields turn to liquid glass. These are the speeds of the future – not only for missiles, but for military and civil aircraft as well.

Curtiss-Wright's subsidiary, Aerophysics Development Corporation – working with the Wright Air Development Center of the U.S.A.F. Air Research and Development Command – has provided an ideal tool for this research in the just-announced HTV Hypersonic Test Vehicle. Reaching several times the speed of sound in only two seconds, this two-stage, ten-foot missile is topped with a two-foot nose cone where data on heat and air pressure are recorded.

The HTV is only the first in a family of such rockets on which Curtiss-Wright task scientists are at work. It is a dramatic example of Curtiss-Wright's developmental leadership in every advanced category of airpower.

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Q: *Chilly day at Thule (−50°F.) . . . how to start fire-crash truck within seconds, provide 90,000 Btu/hr. in small space?*

A: Janitrol liquid heater (tested to −65°F.) keeps engine ready to go, provides cab and cargo heating too!

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A: No need to find it, park the fleet outside —Janitrol liquid heaters keep engines, and bus interiors warm, ready to go at a fraction of cost of new building.

A:

A: Call on Janitrol. If there's a need for heat for the job anywhere, chances are Janitrol can supply it, or build it from service-proved components.

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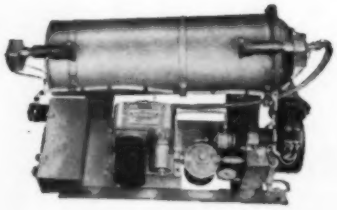
Today the name Janitrol stands for leadership in heating equipment and combustion engineering. Your Janitrol representative is always at your service.



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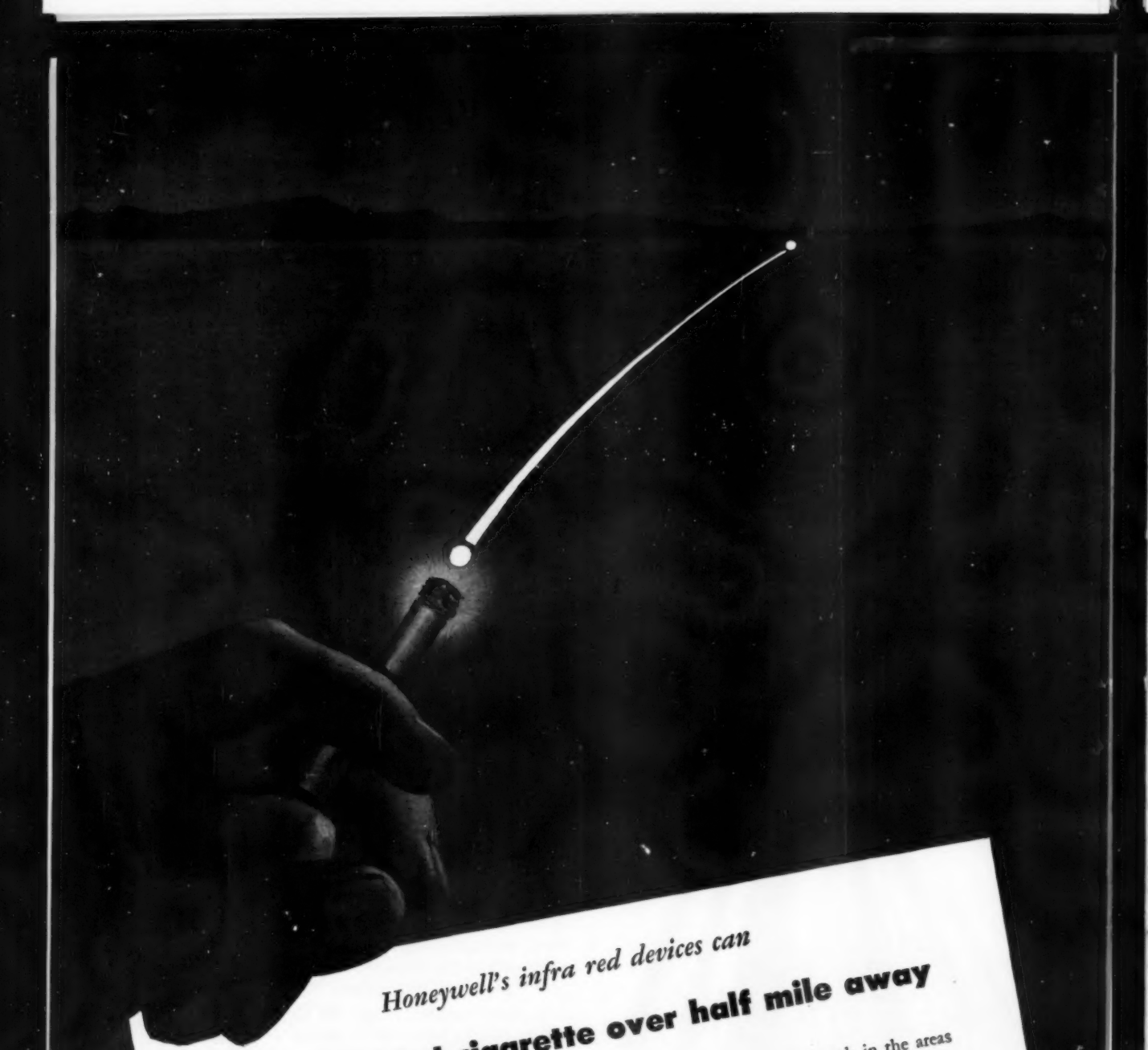

Honeywell's infra red devices can

Detect lighted cigarette over half mile away

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains selected papers presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Evaluating Cutting Fluids

Tapping test permits performance prediction under service conditions

C. D. Flemming and L. H. Sudholz

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FOR many years, much time and effort have been spent in an attempt to develop a simple bench test which would provide a means of predicting the performance of a cutting fluid under service conditions.

A number of the extreme pressure testers have been investigated for this purpose by individuals as well as by organized groups of technical societies. Much useful information has been obtained from these tests, but actual metal-cutting operations have proved more accurate.

At the cutting edge of the tool there are high temperature, high pressure, stressed metal, and a newly formed, "nascent" surface. While bench tests may reproduce the first three of these conditions to some degree, the fourth condition—a nascent surface—can be obtained only by metal cutting.

A NUMBER of test procedures have been developed employing metal-cutting operations. While turning tests have been most widely used, others have been based upon drilling, threading, and tapping. The tapping operation was chosen for the test described in this paper because it fulfilled the following requirements:

(1) simplicity, (2) speed, (3) economy, (4) small test sample, (5) precision, (6) correlation with field results, and (7) severe conditions.

Furthermore, the tapping test has a wide field of use. It is suitable for the evaluation of both nonsoluble and soluble cutting fluids as well as certain drawing compounds. It is also an excellent tool in development programs where antiweld and oiliness additives are investigated.

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THE torques developed during the tapping operations were investigated thoroughly in 1936 at the Iowa Engineering Experiment Station. This study was concerned chiefly with the effect of cutting speed, thread depth, and metal. More recently, the factors affecting tapping torque were investigated by A. J. Carruthers. While both studies included work on cutting-fluid evaluation, this was not the main objective.

Since tap life tests would require extended periods of time they were not adopted in the test development work discussed in the present paper. Instead, torque measurements were employed to determine the relative tapping efficiencies of cutting fluids when compared with an arbitrary standard. In general, the laboratory data so obtained have correlated well with tool life under field service conditions.

Briefly, the test equipment comprises a small drill press equipped with a floating table. The maximum force dur-

ing tapping under standardized conditions is indicated on a scale by means of a torque arm mechanism.

A very sensitive spring scale is used to measure the torque. Some investigators have used strain gages for this purpose. However, experience has shown that the greater sensitivity of the strain gages often has been overshadowed by the variable introduced by the nonuniformity of the metal.

SAE 1020, hot-rolled, having a Brinell hardness number of approximately 120, was selected as the test metal since the tapping of this and similar soft, draggy steels was considered a difficult operation. Furthermore, it proved to be most sensitive to differences in performance characteristics of the cutting fluids and minimized tap wear and breakage.

Subsequent investigation of other metals, such as the higher carbon steels, SAE 1045, 180 Bhn, and the harder, clean-cutting alloys, including heat-treated SAE 3140 steel, 280 Bhn, showed that they were inadequate in these respects.

For a workpiece, a flat 12 inches long, 2 inches wide, and ⅜-inch thick was chosen for ease of handling. Through holes were used to minimize tap breakage and chip binding. It was found that the thickness of the test piece should be ⅜-inch to assure the development of maximum torque.

USE of precision-ground taps rather than the commercial grade is effective in minimizing erratic torque values. Taps consisting of high-speed steel instead of carbon steel are employed to reduce breakage and ensure greater uniformity of results.

A semiautomatic feed mechanism is used to eliminate the variable vertical pressure which often exists when the tap is hand-fed into the hole. This device provides a constant load on the tap through a precompressed spring.

While various tapping speeds were investigated, 25 sfm was finally selected as the most suitable, since it approximates commercial practice and is sufficiently sensitive for cutting evaluations.

A thread depth of 48 per cent proved to be the most desirable because its use resulted in minimum tap wear and breakage and gave good precision. A

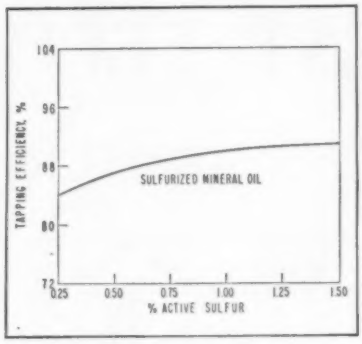


Fig. 1. Tapping efficiency increases as sulfur content of mineral oil is increased.

continuous flow of 1/6 gallons per minute of coolant, directed so that it would contact the tap at the top of the hole was found to be satisfactory.

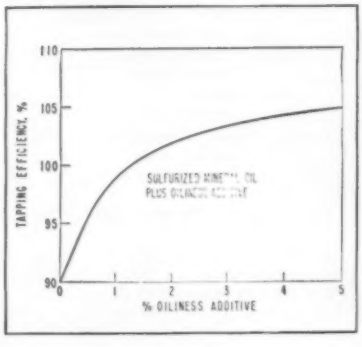
Before performing the actual tapping operation the holes are drilled in the test metal to a tolerance of ± 0.0005-inch. This precision is desirable in order to ensure accurate results. Three drills and a final reamer are used for this purpose.

The test piece with the holes is clamped in a vise, which is attached to the dynamometer table. Six holes are then tapped with each of five taps, making a total of thirty holes for the evaluation. The maximum torque developed during tapping of each hole is indicated on the scale. After an unknown oil has been evaluated in this manner the procedure is repeated with a known oil, which is used as a standard.

The tapping efficiency of an oil is defined by the following formula: Efficiency (per cent) equals

$$\frac{\text{Torque with standard reference fluid}}{\text{Torque with unknown fluid}} \times 100$$

Fig. 2. Increase of synthetic additive improves tapping efficiency of cutting oil.



The torque value for each oil is the average of the maximum torques recorded during the tapping of the thirty holes. In calculating the efficiency of an unknown oil the efficiency of the standard is arbitrarily assigned a value of 100 per cent. Sample calculation:

$$\frac{68.2 \text{ in. lbs.}}{72.0 \text{ in. lbs.}} \times 100 = 95\%$$

In the evaluation of a series of oils, the standard is run first, followed by four unknown oils. Then a run on the standard is repeated. If there has been a change in the torque reading for the standard, due to wear on the tap, variations in metals, etc., this change is taken into consideration in calculating the efficiency of the unknown oils.

IN cases where key products are to be evaluated, duplicate or even triplicate runs are made, but not consecutively. In other words, the accuracy is improved by interposing other products between evaluations of the key product. This practice eliminates the chance of the key product being evaluated on a single piece of test metal which might have abnormal machining properties.

Taps are no longer used when visual inspection, made periodically, reveals slight wear or crushing of the teeth. When taps become badly worn they give about the same torque readings, and use of these values gives erroneous results. Normally about one hundred oils can be evaluated before the taps have to be discarded.

In nearly all cases at least two complete 30-hole tests are run in evaluating a product. If the efficiencies of the first two evaluations are within two per cent of each other, no further work is done. If the spread is greater, another evaluation is performed and the average of the three efficiencies is reported. Agreement between operators is usually within three per cent.

TWO standard reference fluids are used in evaluations. When nonsoluble oils are being tested, an oil of that type is used. An emulsion (1-15) of a heavy-duty soluble oil is used with products of the emulsifiable type. This practice is followed because it facilitates cleaning the coolant system between evaluations. Special cleaning procedures are necessary when a nonsoluble oil is

installed following the evaluation of a water-soluble product.

Using straight mineral oil there is considerable welding and only about one half of the holes can be tapped through. Use of a noncorrosive sulfurized oil relieves sticking of the taps. As the quantity of active sulfur is increased, the tapping efficiency improves due to the decreased welding.

IN the case of water, either the cooling property, the lubricating property, or both, make it possible to tap nearly half of the holes. Emulsions of conventional soluble oils, which are basically blends of mineral oils and emulsifiers, give quite satisfactory results (about eighty-three per cent). However, high efficiencies are obtained only on the heavy-duty types, which contain EP additives.

The curves shown in Figure 3 illustrate how the tapping efficiency of soluble oils decreases as the dilution with water increases. This is true for both conventional and heavy-duty types. Within a certain range, the same tapping efficiency is obtained with a dilute emulsion of a heavy-duty product and a rich one of the conventional type.

However, there are limitations to the degree of dilution. Emulsions which are too lean cause rusting, while rich emulsions (1/4 or less), show tendencies toward inversion.

The test has proved useful in measuring the effect of antiweld materials in nonsoluble oils. Figure 1 shows that as the active sulfur content of a certain sulfurized mineral oil is increased, up to about 1.5 per cent, the tapping efficiency increases. Active sulfur may be defined as that portion of the sulfur which can be removed from an oil by contacting it with copper powder for one hour at 300 degrees Fahrenheit.

THE effect of fatty oils also can be evaluated with the test. Lard oil gives good performance (ninety per cent) whereas a mineral oil is quite ineffective. The addition of lard oil to sulfurized mineral oil results in improved performance.

Figure 2 shows that as the concentration of a certain synthetic additive is increased in a corrosive type of cutting oil, the tapping efficiency improves. The optimum additive concentration is about five per cent.

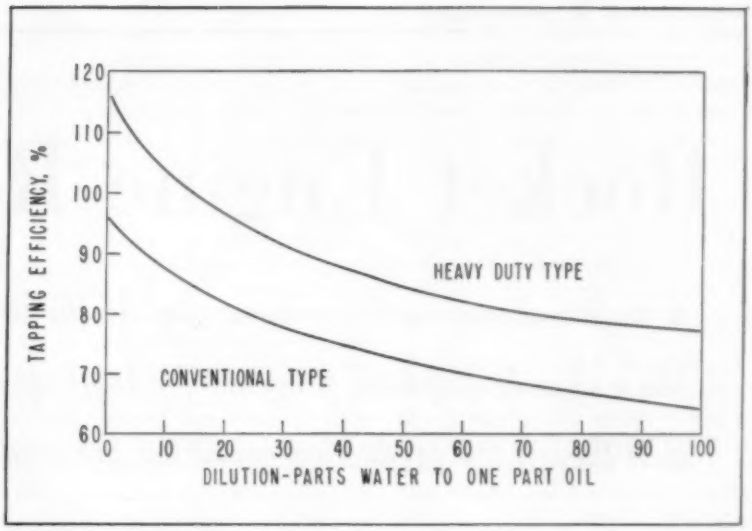


Fig. 3. Tapping efficiency of soluble oils decreases as dilution with water increases.

Over a period of years, products which gave high tapping efficiency generally showed superior tool life and finish in the field. However, in using laboratory data to predict actual performance, consideration must be given to the type of operation and the metal concerned. Correlation has been best in severe operations such as threading and broaching of soft, draggy metals.

Correlation was excellent in the case where various oiliness additives were evaluated for use in corrosive cutting oils. In another instance, wax additives were found to be inadequate. Field experience showed that on soft, draggy metals they were definitely inferior to sulfurized mineral oils.

Other operations, where correlation with tapping results has been good, are pipe threading and certain types of drawing. In one nipple-threading job, guidance was obtained in formulating a product which gave good results when welding and finish were of prime importance. Tapping tests on both SAE 1020 steel and a jet alloy showed that oils having high antiweld properties were required. This was borne out by field experience. The tapping test was helpful in predicting the value of drawing lubricants, especially where steel cartridge cases were concerned.

SOME care should be exercised in using tapping data to predict performance in general. In the first place, the type of metal has to be considered. While the tapping test has been especially useful in measuring performance on soft, draggy steels, it has not been as effective with clean-cutting metals. For example, in the laboratory the tapping of SAE 3140, 280 Bhn; SAE 1045, 180 Bhn; and SAE 1112, 120 Bhn failed to indicate significant differences among products.

THE type of operation also has to be considered when projecting the significance of tapping-test results. There has been little correlation with drilling, forming, cutoff, milling, turning, and other operations involving high speeds and low cutting pressures.

To summarize, the best oil for tapping a soft, draggy steel will probably not be the most satisfactory one for the less severe operations mentioned above. Conversely, an oil which is good for these operations will likely be inferior for tapping and threading.

Many years of experience have shown that the tapping test is a good tool for evaluating cutting fluids because it is simple and economical and gives good precision. It can be used on both nonsoluble and soluble types and for studying the effect of additive material.

The correlation with field performance has been good, especially where severe operations such as threading and broaching are performed on soft, draggy metals.

EDITOR'S NOTE.—Because of the importance of cutting fluids in any ordnance production program, these remarks are especially timely.

Rocket Engine Reliability

A statistical approach can be applied to the reliability demonstration phase of a development program for liquid-propellant rocket engines even though the production quantities are small and testing costs high

A. G. Thatcher and H. A. Barton

A RELIABILITY development program for liquid-propellant rocket engines can be generalized as consisting of two distinct efforts, the first of which is to evolve or develop a system which is believed to have a specified reliability and the second to determine with some degree of assurance that the specified reliability has been achieved.

These two efforts go hand in hand, with the first unable to proceed without the second. Yet, it is the second effort—the proof of a system's reliability—which is of greater concern to liquid rocket engine contractors.

In the minds of many people, the familiar and established techniques for the development of reliability are contained within the development history of piloted aircraft. Hence, to clarify the nature of the problem it is helpful to refer to the circumstances which have prevailed throughout the history of liquid propellant rocket engine development and note how these differ from those of piloted aircraft. These are briefly outlined as follows:

1. There has been a consistent lack of propellant, components, and system design standardization. This, coupled with only limited production which tends to restrict refinement of the successful power plants, has prevented the accumulation of reliability know-how both in design and production up to the present time.

2. The liquid rocket engine is mostly used with large and expensive missiles in which the cost of a rigorous flight-reliability program is often considered prohibitive. This denies to the designer important information concerning how various component design types actually behave under various missile flight conditions.

3. The environments in which the liquid propellant rocket engine and its components will operate can only be approximated prior to flight testing, and adequate telemetered information concerning these cannot always be obtained during flight tests. Further, these environmental conditions tend to be different for each new missile application of the rocket engine.

The above circumstances are in obvious contrast with those of the piloted aircraft. In particular, flight testing is not as limited by budget considerations and, in fact, the piloted aircraft provides an economical in-flight laboratory wherein the components can be observed for improvement under actual conditions.

Lack of this advantage is one of the major obstacles facing those concerned with the development of components for the guided missile. No matter how carefully the design and development program has been conducted, the specified reliability of the engine system can be realized only in missile flight tests appropriately designed for the purpose.

Considering the expense of these flights, however, it would not be economically feasible to begin such a program unless the engine system and other components had been developed and evaluated to a specified value of reliability in a suitable static test program. Without this, the flight tests could all too readily degenerate into a costly component reliability program.

RECENTLY, the development of the guided missile and its liquid propellant rocket engine has been accelerated for several tactical applications. Hence it becomes increasingly important that reliability development be accomplished through the use of additional methods and techniques.

We believe the solution to this problem, in part, can be realized by including in each engine development program a reliability effort which is suggested by the definition of reliability.

Reliability of a liquid propellant rocket engine is defined as the probability that there will be no failure of the unit to operate within design performance limits. In order that an engine system reliability program may be an efficient part of the missile reliability program, these performance limits

Mr. Thatcher and Mr. Barton are both with Reaction Motors, Inc., Denville, N. J. This article is taken from an address given before a recent meeting of the A.O.A. Propulsion Committee of the Guided Missile and Rocket Division.

should be only those which, if exceeded, would cause the missile to deviate from its performance limits.

This definition suggests that the science of statistical analysis be utilized since it is necessary to follow statistical theories in questions of probability. Certainty cannot result from this—only a degree of assurance that any given standard of reliability has been achieved.

THIS degree of assurance in itself is a probability and is referred to as statistical confidence. The definition also indicates that the rocket engine system should have the inherent ability to operate consistently within its design performance limits before a measurement or a demonstration of its reliability is attempted.

With this assumption, then the probability of success of the system depends upon its ability to withstand the detrimental environments to which it will be subjected throughout its useful life.

This suggests that the reliability of the rocket engine system be evaluated by testing within the most severe environments anticipated and the resulting data analyzed by statistical methods.

Although it will invariably be necessary to estimate the types and magnitude of the environmental conditions, rocket engine systems which have been submitted to such procedure will produce a better flight test program.

It is to be expected that these flights will reveal errors in the assumption of the environmental conditions. This will effect reappraisal of the assumed environments and redevelopment of engine components to meet these new conditions.

To include a rigorous reliability effort as part of a development program will increase the cost. However, it is firmly believed that this increased cost will be more than offset by a reduction of future development work on the missile itself.

This fact may not always be fully appreciated in the early stages of a missile program. It is therefore prudent to design an economical reliability program commensurate with military budgets but still yielding sufficient data to provide a statistical basis for reliability.

The proper choice of the statistical techniques can help in reducing the cost of a reliability demonstration program. There are several methods and combinations of methods which can be useful, the choice among which depends upon judgment with respect to the problem at hand.

FOR example, the size and complexity of the system to be evaluated may render one method more suitable than another, or reliability under certain environmental conditions may be evaluated more readily by one method than another.

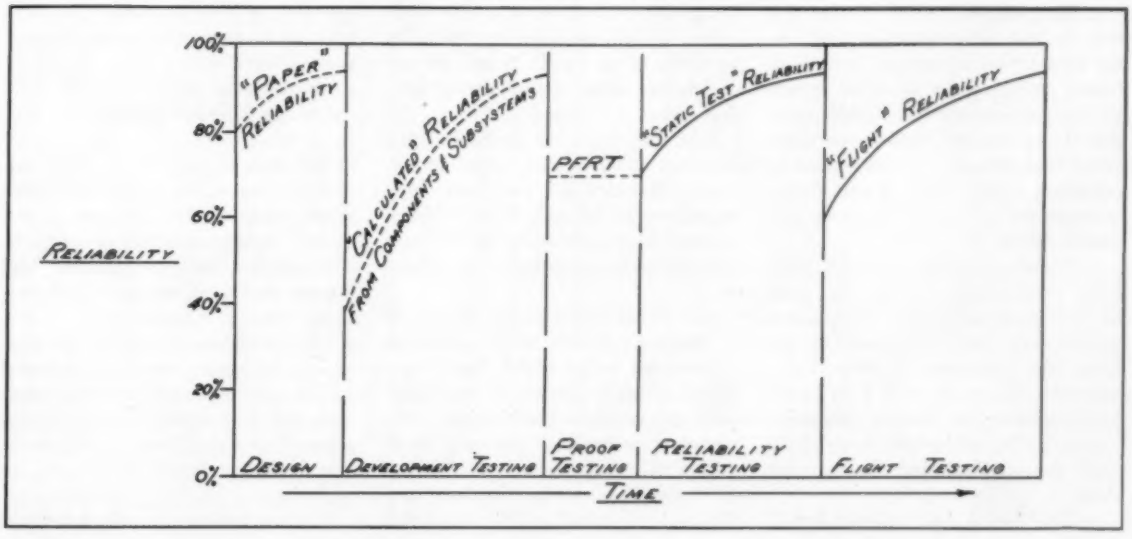
A reliability program resulting from an application of statistical methods is seen to be a broad and complex subject when described adequately to cover all applications of liquid propellant rocket engines. We will only generalize on some of these methods and point out a type of statistical testing which we have found to be most useful in the reliability demonstration phase of an engine development program.

LET us assume that we are charged with the design and development of a typical liquid propellant rocket engine which the bid specifications state should be developed to a reliability of ninety-six per cent with a ninety-five per cent statistical confidence in the result. This engine is to power a guided missile and, therefore, its mission will be to start, operate within specified tolerances, and stop, only once; that is, a so-called one-shot device. However, in practice it must undergo several tests at the engine manufacturer's plant and also at the launching site.

To be effective and realistic, the reliability program for this engine must start at the beginning of a developmental program and play a major rôle throughout. To illustrate this, let us look at the five major phases of a development cycle as shown in Figure 1.

During the design phase the rocket engine system and its components should be under continuous scrutiny to ensure consistency among all aspects of

Fig. 1. Reliability history of a typical liquid rocket engine.



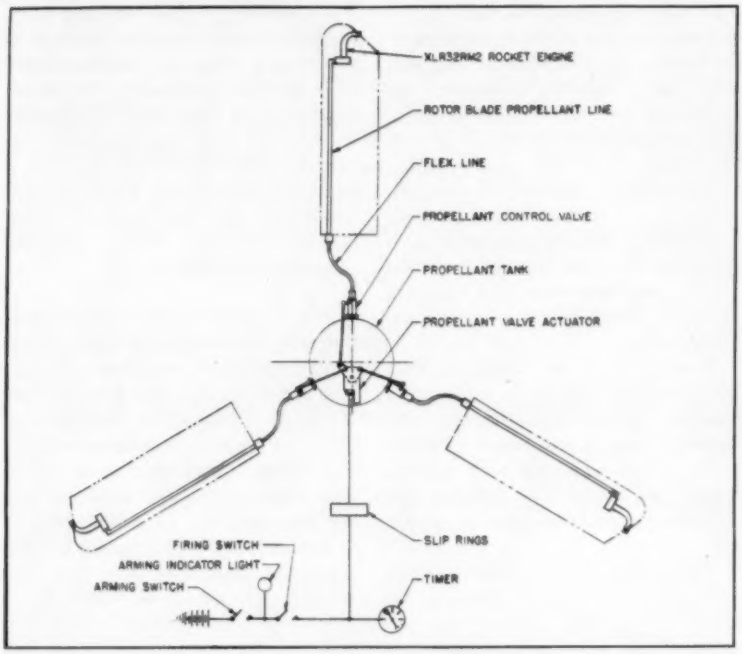


Fig. 2. Diagram of a rocket power plant as applied to an HRS-2 helicopter.

the design and the requirements of reliability.

SYSTEM analysis would be concentrated on the reduction of the complexity of the system since complexity is a major factor of the time and cost required to achieve a specified reliability. Here, sound engineering judgment can be a factor in reducing the cost and complexity of a reliability program by:

1. Designing the rocket engine system to have inherent reliability; *i.e.*, the substitution of systems having inherent characteristics for those requiring complex controls. For example, complex thrust chamber controls and safety circuits can oftentimes be eliminated by propellant choice and unique design arrangement among the injector, propellant valves, and system.

2. Choosing designs favoring reliability even though compromises must often be made with regard to maximum performance and minimum weight. Here missile designers can help as they are prone to specify such high power plant performance that a propulsion system having critical characteristics is often necessary to meet the specifications.

3. Utilizing design concepts proved to be reliable in past programs on similar systems and rejecting questionable design approaches or those that may require an excessive amount of development time. Thus, the desire to improve the art must be tempered by reliability requirements as well as development schedules.

The engine system illustrated in Figure 2 is an excellent example of the use of the above design concepts. This helicopter auxiliary power plant (ROR) brings proven concepts to a new application. It achieves inherent reliability by virtue of its simplicity and the use of catalytic rather than electrical ignition means.

Admittedly, it is not the highest performing system which could be designed. However it is sufficiently high to perform its job well. It has achieved a record of 99.5 per cent reliability over approximately 2,500 flight operational cycles.

The development-testing phase will be directed primarily toward achieving a prototype design which has the inherent ability to perform in accordance with the required specifications, even under environmental extremes. It is within this phase that the reliability of each component under simulated conditions is improved until it approaches a preassigned value consistent with the over-all system reliability figure.

Judgment must be exercised to concentrate only on those components or subsystems whose operating conditions can truly be simulated by bench testing, such as solenoid valves, pressure switches, etc.

THE proof-testing phase of the development program concerns those tests which are routine requirements of all newly developed units and which must be performed before the unit can be considered ready for flight. The proof-testing phase includes acceptance, flight approval, and qualification tests. The latter two may be conducted prior to or coincident with the reliability demonstration phase.

This newest phase of a developmental cycle is becoming known as the reliability demonstration phase in bid specifications for rocket engine systems. Within this phase, the sequence of engine system reliability evaluation, improvement, and reëvaluation within simulated environmental conditions in static testing takes place until the specified reliability has been demonstrated.

This phase of the program should be conducted parallel with the reliability testing phase as it is important that the unexpected environmental conditions that are encountered in flight be fed back into the reliability testing phase. Only in this way will an efficient overall reliability program result.

The remainder of this paper deals with the problem of demonstrating that the specified reliability has been achieved on an engine system by a program of static testing which should be conducted prior to and parallel with the missile flight test program.

THE type of data which can be analyzed statistically to determine reliability may be derived from two general types of testing classified as testing by attributes and testing by variables. Testing by attributes concerns itself only as to whether a sample is, or is not, within specifications. In reliability evaluation the system would be operated within a selected environmental condition, and the number of times the unit operated or did not operate within the specified limits would be the basis for analysis.

Testing by variables is concerned

with the actual value of the measurements and how they vary from one sample to another. For reliability evaluation, the system would be operated with the simulated environmental conditions increased in severity for each run. The levels at which the system ceased to operate within specifications would constitute the data which would be subject to statistical analysis to determine the probability of failure under the maximum environmental level expected in service.

This type of testing is sometimes referred to as test to failure and is not generally favored for system testing, as it can involve difficult and expensive test procedures. On the other hand, this method can be used effectively, in many cases, for evaluation of the individual components of the system in the earlier part of the development program.

The data which results from either of these two types of testing can be obtained by several sampling plans, the choice among these depending upon which serves the best interests of the program. Obviously, the best interests are served when the testing plan is such as to provide the most information for the least cost.

EVERY test that is made on a large liquid propellant rocket engine system is expensive as is the test installation itself. Therefore, a method is desired which permits testing to terminate as soon as sufficient data have been accumulated from which a decision as to the reliability of the system can be made without requiring complicated manipulation of the environmental conditions.

It is believed that these conditions are realized by testing the rocket engine system in a program of testing by attributes following the methods of sequential analysis.

Sequential analysis is a fairly recent addition to statistical science, the details of which are adequately outlined in current tests. The method is based, first, on the premise that the sample size, or, in our case, the number of tests required, is an independent variable and for fixed-risk limits the expected number of trials is a minimum.

Secondly, the number of observations needed to decide quality with a given risk between two specific postulated values is less than that required to decide between one value and all possible alternatives. With this method it is not necessary to be concerned with other statistics such as distributions or variances.

The manner of its use consists of conducting a series of tests within a simulated environmental condition and noting the number of successful and nonsuccessful tests as they occur in sequence. After each test, the probability of observing such a sequence of events with respect to the specified reliability (R_1) and some other alternative value (R_2) is calculated by means of the likelihood ratio $\left(\frac{P_2}{P_1}\right)$ after which one of three decisions can be made, as follows:

1. The specified reliability has been demonstrated.
2. An alternative reliability value is indicated and therefore the system has not demonstrated the specified reliability.
3. Sufficient observations have not yet been made to come to any decision and a further test must be made.

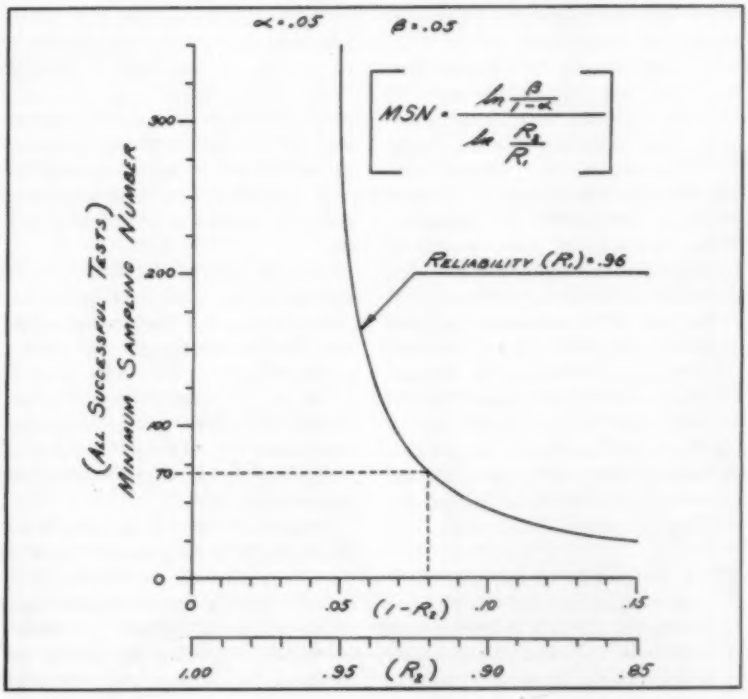
A graph was plotted of the likelihood ratio equated to the risk limits which can be used rather than making calculations after each test. On this graph an example is shown of twenty-five successful tests, an unsuccessful test, followed thereafter by forty-five successful tests, another unsuccessful test, and then thirty successful tests, which resulted in a decision that the specified reliability had been demonstrated.

THE limits for the probabilities upon which the above decisions are based are known as the alpha (α) and beta (β) risks. The value of α represents the probability that the engine system will be rejected by the testing plan even though its true reliability equals the specified reliability ($R = R_1$) and is known as the producer's risk.

The value of β indicates the probability that the engine system will be accepted by the testing plan although the true reliability does not equal the specified reliability ($R \pm R_1$) and is known as the consumer's risk. The value for this risk is indicated in the bid specifications by the statistical confidence desired in the reliability evaluation and is equal to that value subtracted from one. For our engine system, $\beta = (1.00 - 0.95) = 0.05$.

With the specified reliability (R_1) and the consumer's risk (β) fixed by

Fig. 3. Minimum sampling number versus alternative values (R_2).



the bid specifications, the average and minimum number of tests required to reach a decision in the sequential analysis depends upon the values selected for the alternative reliability value (R_2) and the producer's risk (α) and become less with smaller values of R_2 (Figure 3) and larger values of α.

Judgment must be exercised in selecting these values. The value for α is selected by the contractor from economic considerations and the risk he is willing to take of having the system rejected when, in fact, it has the specified reliability. The value of R_2 should be judged from the prior knowledge of the approximate system reliability which can be derived from the component reliability evaluation during the early part of the program and the relationship that exists between the components and system reliability.

IN other words, the amount of testing of the system will depend upon how completely the component reliabilities were determined. With the values of R_1, R_2, α and β established, the average sample number equation can be used, together with suitable contingency factors, for estimating the scope of the test program for budgeting purposes.

The stipulated conditions within which the test program is to be conducted are fundamental to the reliability program since it is against these conditions that the demonstration of reliability is made. Here, some judgment must be exercised in combining certain environmental conditions such that they represent the most likely combinations detrimental to reliability. These combinations form groups of conditions, or test types, within which the sequence of tests is performed.

The cost of the reliability program depends a great deal upon how extensively these environments are selected. Comprehensive selection would involve a broad range of environments including those associated with transportation and storage along with those which are expected when the rocket engine system is in operation in the missile.

FOR the purpose of this demonstration we have assumed that a limited environmental coverage is desired—that is, only those environments most likely to be encountered in starting, running at specified conditions, and stopping during flight or ground checkout operations of the missile.

THE number of engine system components required for the testing program, including the allowable expendables, should be procured preferably by random selection from a larger production quantity. From these components, three engine systems would be assembled for the sequential testing, one for each test type, and first subjected to acceptance tests, since all engine systems must survive these and subsequently be reliable in the field.

Thereafter the systems would be subjected to the sequential testing within the conditions of the test type to which each assembly has been assigned and the number of successful and nonsuccessful runs tabulated as previously described.

During the course of the sequential testing the engine system will periodically accumulate running time equivalent to that of its useful service life. To avoid the possibility of wear-out becoming a factor of the reliability evaluation, the system at these intervals should be subjected to routine overhaul procedures.

Since these servicing procedures would be the same as those specified for the production system, they can be considered one of the environments of the testing program and, in general, consist of teardown, inspection, and the replacement of specified components in reassembly. The requirement for replacement of any component beyond that allowed by these procedures would be deemed a performance failure.

Now, let us consider what can be expected to be established by the reliability testing plan for this engine system. Results that could be of interest might include: (1) Reliability of a particular engine system design, (2) reliability of a typical production engine system, and (3) reliability of a limited number of typical engine systems for repeated operation.

It would appear that the latter is the result that is to be expected, yet it is the first two which are desired. From a consideration of the assumptions upon which statistical methods are based, statements can be made relating the results of the test program to the reliability of the engine system design and future production engines. Three important assumptions are as follows:

1. It should be equally likely that the engines selected have a reliability either superior or inferior to the average of all engines produced or that can be produced under similar circumstances.

This assumption is often difficult to meet under the circumstances of limited production. However, if the total quantities required for the proof-testing phase, the reliability-demonstration phase, and the preliminary flight test program can be arranged as a production run, and the units chosen at random from this run, then a close approximation to this assumption can be realized.

2. The observations of the statistical test program must be independent; *i.e.*, the probability of the outcome of each test should not be influenced by the previous test.

Here it is necessary to assume that the tests are, in fact, independent, and, except for the wear-out effect of accumulative running time, this is correct.

3. The systems making up the future production quantity are to be produced by operations which are in statistical control; *i.e.*, the unavoidable variations arise only from a constant system of chance causes.

The means by which this is accomplished is by the application of a production statistical quality control plan, based upon the component design tolerances found satisfactory during the earlier development program.

The results of such a test program, then, do indicate that the engine system design can result in future systems having ninety-six per cent reliability within the environments assumed.

THE results also indicate that ninety-five per cent of all engines to be produced under circumstances similar to those which produced the engines tested will meet the specified reliability.

To summarize, we have described some of the reliability difficulties which plague the liquid propellant rocket industry and how a statistical approach can be applied to the reliability demonstration phase of a development program even though the production quantities are small, the cost of testing is high, and some of the environmental conditions of the testing are assumed.

Honeycomb Core Materials

Increasing use of the various types is making possible the construction of "sandwich" panels of great rigidity, light weight, and good insulating properties which will help solve some pressing structural design problems

A. J. Carah

SANDWICH construction is an old process. The corrugated paper carton, first manufactured by Thompson and Norris in 1875, is an outstanding example of this method of construction. As early as 1935 the DC-3 used balsa core plywood sandwich floor panels. Perhaps even earlier examples of aircraft applications exist. Paper honeycomb, using a core normal to the faces, was developed about this time.

However, the extensive structural use of this concept did not come about until the development of synthetic resin adhesives capable of bonding the core materials to metal, and metal to itself. Chance Vought in 1946 built a Navy fighter aircraft having an almost completely monocoque structure using end-grain balsa core material separating two thin structural sheets of aluminum alloy. This structure all but eliminated the need for internal frames and maintained a smooth, nonwrinkling surface up to the ultimate strength of the airplane.

WHILE this development was progressing, structural engineers were searching for ways to make the core materials lighter and stronger. The Glenn L. Martin Company developed an adhesive which made paper honeycomb practical for structural use. U. S. Plywood was licensed to produce this material in both paper and phenolic-impregnated cotton fabric. These materials suffered from low strength in the case of the paper and high cost for both, since high quantity production machinery did not exist for manufacturing the honeycomb.

Mr. Carah is assistant design engineer with the Douglas Aircraft Company, Santa Monica, Calif. This article is taken from an address given before the Structures Committee of the A.O.A. Guided Missile and Rocket Division, Fort Bliss, Tex., recently.

In 1947, the Douglas Aircraft Company became interested in the manufacture of prefabricated houses using aluminum alloy structural sheets and paper honeycomb core material. As part of the work on this unit, a method of manufacturing a truly structural high-strength paper core and a machine for its production in quantity were developed.

For economic reasons, nothing came of the prefabricated houses, but the capacity for manufacturing the paper honeycomb core material by Douglas alone has grown to an annual quantity of six million board feet. Flat sandwich panels of all descriptions are produced by the thousands. Missile wings and other structural components are in regular production.

Honeycomb core is manufactured in a variety of materials, sizes, and characteristics, some of which are shown on page 729.

Nonstructural paper honeycomb is a low-strength, lightweight material used extensively for nonstructural panels, packaging, cushioning, and other noncritical applications. Cell shapes are either hexagonal or corrugated.

Aircomb or structural paper honeycomb is a high-strength core material using a phenolic- or vinyl-impregnated paper which is arranged in hexagonal cells.

Fabric honeycomb is similar to the structural paper core material, but cotton duck or fiber glass cloth impregnated with phenolic or other plastics is the basic material.

ALUMINUM honeycomb is also similar to the structural paper, but phenolic-bonded aluminum foil arranged in hexagonal or square cells is used.

A recent development showing much promise as a high-strength, high-temperature structural material is stainless-steel honeycomb. Cells are hexagonal or square of stainless foil spot-welded or brazed together. Normal assembly into panels is by dry hydrogen brazing.

Honeycomb core material, when bonded into panels, is capable of working the face materials up to their yield strength. The core thus carries shear, tension, or compression components normal to the skin and stabilizes the faces, preventing early buckling. The higher the core strength, the more critical is its bonding to the faces. The shear and compression strengths of

Material	*Cell Pitch (in.)*	*Weight (lb./cu. ft.)*	*Crushing Strength (p.s.i.)*	*Shear Strength (p.s.i.)*
60 lb. paper (impregnated)	.44	1.70	130	40
110 lb. paper	.48	2.95	240	53
0.003 aluminum foil	.38	4.20	455	85
0.002 aluminum foil	.25	4.30	475	90
4 oz. cotton duck (impregnated)	.44	4.70	380	90
125 lb. paper (impregnated)	.35	4.90	620	162
0.004 aluminum foil	.38	5.40	660	140
0.003 aluminum foil	.25	6.10	780	175
0.004 aluminum foil	.25	7.85	1090	270
8 oz. cotton duck (impregnated)	.44	8.60	1000	204
0.002 stainless (type 321)	.25	9.60	500	310
0.002 stainless (17-7PH 180,000)	.25	9.60	4000	500

Table 1. Strength properties of honeycomb cores.

honeycomb core materials vary almost directly with the weight of the core. Relative strengths and weights are shown in Table 1.

The insulation properties of honeycomb panels are a function of the core material, its thickness, and the size of the honeycomb reticule. Fabric honeycombs are best, paper intermediate, and metal foils the poorest insulators. The insulation value of a given paper panel may be improved by a factor of 1.5 if the cells are filled with a lightweight plastic foam.

Where a very rigid lightweight structural panel is required, honeycomb provides an ideal material as indicated in Table 2 which compares the weight of flat rectangular beams of equal rigidity.

THIS characteristic is one of the major advantages of the honeycomb panel over other types of construction, especially for airborne applications or where parts must be easily handled, such as scaffolding or tooling platforms.

Its excellent rigidity-weight ratio makes its use especially attractive for very thin aërodynamic surfaces, where conventional construction would result in serious aëroelastic deformations which frequently cause structural failure or reversal of control. This is shown in Table 3, comparing the same fin made by conventional construction and of paper honeycomb.

Honeycomb-core sandwiches also provide an exceptionally smooth, wrinkle-free surface at all loads up to the yield strength of the face material. This feature is important in structural and decorative panels and is particularly advantageous for aërodynamic surfaces.

For flat panels the cost per square foot of honeycomb construction is low in comparison with panels of equal rigidity of other types of construction, since very thin faces are used and the core materials are quite inexpensive. Tooling cost for flat panels is negligible.

Even for tapered sections, such as aërodynamic surfaces, the finished parts are usually cheaper in honeycomb than in conventional structure, since tooling and material costs are about equal and assembly time is considerably less.

The following table compares two similar surfaces, one of honeycomb and one of conventional rib and spar construction.

Table 2. Comparative data on equal rigidity of flat rectangular beams.

Beam Descrip.	*E* (x10⁶)*	*I* (b = 12)*	*Rig. Fact. (EI)*	*Panel Thick. (inches)*	*Weight (lb./ft.²)*	*Beam Wt.Rat. (aircomb = 1)*	*Rel. Cost (aircomb = 1)*
Aircomb panel**	8.0	.099	792,000	1.032	.734	1	1.0
Birch plywood	1.25	.634	792,000	.86	3.26	4.45	.75
Aluminum	10.5	.0755	792,000	.422	5.96	8.14	2.52
Steel	30.0	.0264	792,000	.296	12.0	16.4	1.20

* E and I are for face material only.

** 60 lb. paper, 0.016 aluminum alloy faces.

Construction	*Relative Cost*
Honeycomb	1.0
Conventional	1.4

As with any method of construction, honeycomb sandwiches have some disadvantages, some inherent in the material and some because the state of the art is still young and methods of overcoming these disadvantages have not yet been developed. It is very probable that in time solutions to most of these problems will be reached, since a great deal of work is now being done toward this end and progress is encouraging.

Inspection methods for determining the quality of the adhesive bond of the honeycomb core to the face panels and of edge members to core and faces are not yet developed to the point where one hundred per cent confidence in the results can be guaranteed. Originally panels were inspected by proof testing which guaranteed their ability to take load rather than the soundness of the bond. This method is still used in some applications.

A SECOND method was developed using a sound box. The panel to be tested is placed on top of the sound box and uniformly covered with a light sprinkling of sand. Speakers in the box are operated through the entire audible range and unbonded areas are indicated by bare spots forming in the sand pattern.

While reliable, the method is slow and cumbersome and has been used recently on a sampling basis only. It should be pointed out that this method does not otherwise determine the quality of the bond.

A more reliable and more rapid inspection method has recently been devised by the Stanford Research Institute. This is the Stub (Stanford Ultrasonic Bond) meter, which indicates a change in the damping of an ultrasonic beam, caused by an unbonded area, on a cathode-ray tube. This equipment is receiving wide acceptance and has a very high probability of detecting bonding flaws.

The primary method of ensuring good bonds, however, is the very stringent control of all phases of the processing.

Because of the nature of the present-

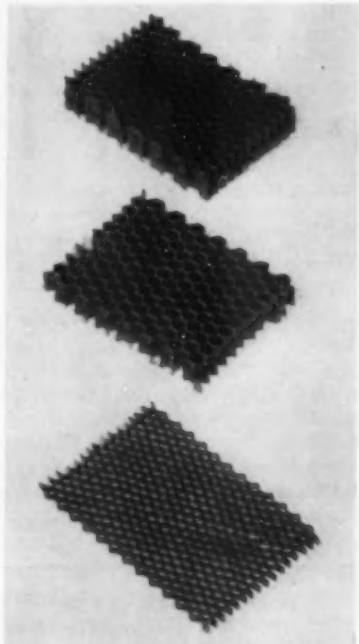
day adhesives and the fact that inspection of the results is difficult, exceptionally stringent control of all processes in the fabrication of the panels is required.

Particularly critical is shelf life and mixing of the adhesives, cleanliness of the entire process including cleaning of all components, and tolerances on the thickness of the core. Edge members must be thinner than the core or must be designed to deflect under the relatively low bonding pressure if adequate adhesive bond is to be attained adjacent to the edges.

Unless panel edges are sealed, moisture is absorbed by the paper or cloth and the shear and compression strength are reduced. If the material is immersed in water for 30 days the strength is reduced to 25 to 40 per cent of the original dry strength. These values will return to normal after drying out. Applications in moist or wet conditions must be designed to the reduced values or must be thoroughly sealed. The strength of metal foil honeycomb structures is not appreciably affected by moisture or immersion, except for a slight reduction in bond strength.

A more serious problem than loss of strength frequently results from moisture absorption in the paper or fabric cores. This is corrosion of the faces and other structural members in contact with the wet core. The corrosion in itself is serious enough, often resulting in degradation of the strength of the structural members, but a secondary effect is sometimes even more serious. This is the weakening of the bond itself due to interaction of the corrosion products with certain types of adhesives.

THE worst offenders in this respect are magnesium structural members in combination with the epoxy adhesives. Static tests of missile fins returned from service show a reduction in strength of up to fifty per cent due to corrosion of this nature. Aluminum is subject to the same problems but to a lesser degree. The phenolic-base adhesives have so far shown little deterioration in contact with moisture or wet core materials.



Three types of honeycomb construction, top to bottom: phenolic 125-pound paper, phenolic cotton duck, phenolic fiber glass.

Impact strength of a honeycomb panel is a somewhat different concept than impact strength of metals. For the latter, it is a measure of the resistance to failure in bending across a notch when the specimen is subjected to a blow. For honeycomb it is the resistance to local crushing of the core under a blow upon one of the faces.

While the resistance of honeycomb core to blows of this sort is low, the over-all affect of such crushed and weakened areas in a typical sandwich structure is negligible unless large areas of the panel have been crushed.

Extensive use of paper honeycomb as a structural material began in 1947 when the first military van-type trailers were developed. This trailer had such high rigidity requirements, due to the alignment error limits of a radar antenna mounted on its roof, that conventional trailer construction of frames, stringers, and skin was out of the question.

The design requirements for this class of trailers were stringent. Rigidity was paramount; high strength was required for sandbag loads on the roof and resistance to high wind loads. The structure had to be rugged enough for cross-country travel over rough terrain but light enough to be transported by air. Sealing was required to allow stream fording and to prevent rain damage to the electronic gear carried by the trailers. For operations in any climate the heat transfer through the structure had to be held to a minimum.

THE honeycomb structure then being developed met most of these requirements, and a series of trailers was designed and placed in production using nonstrategic magnesium panel facing.

These trailers proved satisfactory in service with one major exception. It was found to be next to impossible to seal off the panels completely against the entry of some moisture into the honeycomb. The paper, acting as a sponge, retained the moisture in contact with the magnesium skin and the epoxy adhesive, and in a number of cases severe corrosion of the magnesium panels occurred.

Changing the magnesium faces to aluminum and improving sealing methods have largely eliminated this problem.

Where the nature of air cargo requires large containers for protection, or palletizing for ease of handling, honeycomb panels have been used to advantage. Most cargo containers have used pressed paper faces though some have been made using light-gauge aluminum. Pallets are generally aluminum-faced.

These desirable characteristics are not attained without some disadvantages, such as difficulty of inspection of the bond, stringent process controls, low impact strength normal to the faces, low wet strength of paper and fabric cores, and possible corrosion problems with some combinations of materials if sealing is inadequate.

Table 3. Characteristics of conventional and paper honeycomb fin compared.

	Deflection at Limit Load (Inches)	*Weight of Fin (Pounds)*	*Failure Load (Pounds)*
Conventional fin	2.1	25.3	5,250
Paper Honeycomb Fin	1.8	22.2	6,300

Ordnance Must Be Ready

Obsolescent military equipment must be kept modernized, new designs must be evolved, and production must be maintained if our troops are to have up-to-date armament in being and in the supply line for any emergency

Capt. Raymond Marsh, Jr.

HOW to maintain an adequate instant supply of modern military equipment is a national defense problem whose solution is as complex as the problem is important. Let us discuss this problem from as practical, economical, and efficient a point of view as is possible.

During this discussion we will consider points which concern themselves with using and modifying what we have along the lines that we now utilize and with keeping our designers and planners constantly abreast of the situation, using only the minimum types of equipment and utilizing those commercial commodities that are of proven merit.

But first let us look at the problem as it has existed during the years that have just passed and those we are going through now.

OUR World War II and Korea experiences left us with a wealth of information as to the types of equipment required by modern armies operating under a wide variety of climatic and terrain conditions. The end of the shooting left us with a large quantity of this equipment on hand and in use. When originally built, this equipment embodied the latest known military requirements and also the most up-to-date technical characteristics.

When we find ourselves thus possessed of large volumes of equipment, what can be done to keep this equipment abreast of the times from both the tactical and technical viewpoints? The answer which we finally develop should be as applicable to any comparable future situation as it was after World War II and Korea.

Captain Marsh is an Ordnance Corps officer with the Tokyo Ordnance Depot, Japan.

The sentiment of the country, the condition of our national economy, and the attitude of Congress would never permit the wholesale scrapping of any large quantity of equipment just because it was some five years or so out of date. Therefore, the first problem is one of modernization and modification of existing equipment. This can be done by the replacement of archaic or worn-out subassemblies.

Some of this replacement work may be capable of being done by the troops themselves or by maintenance units belonging to the mobile armies. Some replacement may require the more elaborate equipment of arsenals and manufacturing plants.

Certainly, the replacement and modernization work on equipment in storage must be done by the permanent establishments of the supply arms and services and must be done in such volume that all vehicles issued to the Army will be up to date, technically at least.

While existing stocks are thus being kept in an up-to-date technical condition, the designers and framers of military characteristics can and should be kept busy designing equipment that will embody the latest technical improvements and incorporate such special military characteristics as our military planners consider essential to the successful conduct of a future war.

Such designs as may be thus produced must not be considered as being just mere paper work developed for academic reasons. They must be practical and must give careful consideration to the utilization of existing equipment and parts thereof; to the employment of tools, jigs, dies, and fixtures in the possession of American industry; to the availability of raw materials; and to the possibilities of shortages of strategic items.

THE development of these modern designs calls for the closest coöperation and collaboration with industry because it is American industry which will manufacture the items covered by these designs. The manufacturing facilities of the Army will do little more than produce the pilot models.

The industrial automotive engineers and manufacturers should be called upon to scrutinize the Army's designs to determine if they can be produced without the development of special-purpose machines and methods. Can industry, in peacetime, produce these items in the quantities desired without disrupting normal commercial production; and, in the event of war, can the items be produced in the quantities re-

quired within the limits of time available?

It must be recognized that commercial industry, under the spur of competition, is continually developing improvements in products and production methods. The Army must not fail to avail itself of every one of these technical advances and improvements.

IN the development of these peacetime designs, the Army can do a great deal in the solution of its supply problems by limiting the number of types of equipment. All too often we find a combat arm asking for a special type of equipment to meet a special-type problem of combat or transportation when a vehicle already in existence could meet the need with but little modification and with but little compromise on the desired functions of the proposed item. Types of equipment should be held to the absolute minimum in number.

Military designs also should take advantage of every possible use of standard commercial components and subassemblies. Commercially, regardless of the name plate, we find on a number of automotive products the same make generator or starter, wheels, propeller shafts, engine valves, and many other components and subassemblies.

After full advantage has been taken of commerical practices and improvements, industrial collaboration has assured a vehicle capable of quantity production, and the Army itself has incorporated in the design all the desired military characteristics that are within the realms of practical engineering—then, and then only, will we have a sound, modern, up-to-date design.

One other step is necessary before consideration can be given to the manufacture and the issue of these new items to replace wartime types, and that step is a service test.

SERVICE tests are acknowledged to be an essential step in the standardization of any military item. However, very frequently the new item is available for such service tests in such limited quantity that the service testing board finds itself investigating the technical characteristics of the item rather than determining its tactical possibilities and finding out if it meets fully the desired military characteristics and, if not, just wherein is it lacking. Therefore, new vehicles should be made available in such quantities for service tests as will permit the equipping of a complete tactical unit.

With the service test completed and the vehicle approved or modified as may be necessary, we are ready to consider the number to produce and procure. From our existing troop basis we can readily determine the total number of vehicles of the type or types we are considering that are required to equip completely these military units. To this number we must add those quantites that have been determined necessary to fill the pipelines in the channels of supply.

In peacetime, funds are always more or less a problem, and, in the past, in only a few instances has the Army ever been able to obtain all the things it desired in the quantities considered necessary. The question which it has been compelled to answer was not "How many do we need?" but rather "How many can we buy?"

IT is not proposed at this time to engage in any discussion of the political or economic situation or to suggest ways and means whereby appropriations for the armed services may be increased or otherwise affected, but the question of the availability of funds is raised because of the controlling influence it has on the procurement plans and on any replacement program which may be developed. At any rate, the fiscal situation almost invariably causes the Army to hold its requirements to a minimum.

Thus, in determining how many of these up-to-date items we may need, advantage should be taken of any measures which may reduce the quantity. In the case of combat vehicles, the troop basis and demands of the pipeline fix the quantities without argument. The only way those quantities may be reduced is through reduction of the troop basis or, and this is frequently possible, by reducing the time lag in the supply line.

However, it is in the category of supply and transportation vehicles where large reductions may be effected. The motor vehicle demands for the Army include not only the requirements for troop units and the supply pipeline needs but also the requirements for posts, camps and stations, manufacturing arsenals, depots, bases, ports of embarkation, and other similar installations.

THOSE military establishments must have motor vehicles of various kinds, and there is no inclination to set up any rigid motor vehicle limitations for them. Their requirements, however, for motor vehicles can be met by supplying them with standard commercial vehicles bought in accordance with established procedure on the open market out of commercial production.

There is no reason why, on any supply depot, the hauling of supplies in and around the depot must be done in multiaxle, all-wheel drive, dual-tired vehicles of high cross-country mobility such as are required by the military operations in the field.

Messenger service in installations of the Zone of Interior need not be performed in jeeps—a motorcycle with side-car or an ordinary scooter can do the job just as well. Passenger transpor-

Ordnance for our troops in Japan is kept modernized and repaired in this modern machine shop at the Tokyo Ordnance Depot (Army Photo).

tation at military hearquarters within the continental limits of the United States can be done by standard commercial carriers quite as well as by any kind of military troop carrier.

By denying to such installations the use of strictly military-type vehicles, our requirements for such vehicles will be materially lowered and the size of our basic problem correspondingly decreased. By this utilization of commercial vehicles our military maintenance and spare-parts problem also will be reduced because these Zone of Interior establishments can solve their automotive-maintenance and spare-parts problem in the same manner that the corresponding problems are solved by business firms that have their industrial plants and activities distributed all over the United States. For example, how do the Railway Express and the several Standard Oil Companies accomplish their maintenance and spare-parts acquisition? By utilization of local repair and spare-parts facilities of the dealers and sales agencies of the commerical vehicles they are using.

THE quantities of motor vehicles used by these Zone of Interior installations total up to an impressive figure and the reduction of the requirements for strictly military vehicles by this total would materially reduce the problem of special tooling, special processing, and special materials that might be demanded for the motor vehicles for military tactical units.

Likewise, placing the problem of maintenance and spare parts for these vehicles upon already established and permanently located civilian service shops and sales agencies would reduce the demands for maintenance and spare parts placed upon the normally overloaded peacetime maintenance and spare-parts supply facilities of the Army.

Now we are ready to talk to manufacturers in the terms of specific quantities. But are we? So far, we find our Army equipped, completely, we may assume, with items of some wartime vintage or items procured over a long period of peace. By a continuous and usually costly program of maintenance and modification, we have kept these vehicles operating and in a reasonably modern condition.

While this was going on, our designers and framers of military characteristics have, with the coöperation and collaboration of the automotive industry, produced a practical, manufacturable design of a modern military item.

We have restricted the use of these vehicles to military tactical organizations and, based on the troop basis of the period and supply factors of the time, we have reached the figure which shows how many such vehicles would be needed completely to equip the Army with up-to-the-minute items.

Is it possible that we can initiate the procurement of that number of items? As has been mentioned earlier, it is almost never possible to scrap matériel just because it happens to be old or out of date, especially when it may be maintained in some kind of serviceable operating condition.

Although far from their original source of supply, these tank engines are kept in good operating condition by careful maintenance (Army photo).

It is also necessary to bear continually in mind the availability of appropriated funds. Finally, an answer is shaped up as to how many we can buy based on the number of items that must be scrapped each year and over how many years we can afford, financially and militarily to spread reëquipment of the Army with this particular item.

FOR the purpose of this discussion let us say we have determined that this reëquipment of the Army with the new item must be accomplished in not more than n years and therefore that we will procure each year $1/n$ of the total number of items we have determined to be necessary to accomplish this reëquipment.

So on that basis we initiate the procurement of this number of items and talk to the automotive industry in terms of the definite number of items we need.

This is not the end of our problem, however, because time marches on, and it can be foreseen that these items, so carefully designed, tested, modified, and discussed with the automotive engineers one day will be relatively as obsolete as the vehicles with which we originally started.

We want to avoid any delays in the production of this $1/n$ on the items we need so badly. We must avoid holding up production while some one part, vital or otherwise, must be modified to bring it in harmony with some recent improvement. We will therefore freeze the design of these items during their manufacturing period.

While the manufacturers are producing these design-frozen items, our designers and military engineers will be working on the design of another item of this same type and incorporating in that design all the improvements and any changes in military characteristics our military planners consider necessary.

THIS design should be subjected to the same scrutiny by industrial engineers with respect to its practicability and manufacturing capabilities as we have discussed previously.

If necessary, pilot models should be constructed and a service test conducted. If, however, the changes in this new design are technical and do not

involve military characteristics, no service tests should be necessary. In fact, in the interests of economy in time and money, no service test should be permitted.

By the time the manufacture of $1/n$ of our desired vehicles is completed, this new, improved, and modified design and the testing of its pilot model should have been finished and the next $1/n$ of our items that are to be procured should be produced in accordance with this new design. This design, like the first, should be frozen while this particular lot of vehicles is being manufactured.

By following this program of design, collaboration with industry, service testing, replacement on a scheduled basis, freezing of design during manufacture of any annual quota, continuous working on new designs involving the latest technical improvements and the most recent military demands, and producing next year's quota on the basis of this revised design, we will finally have our Army supplied with equipment none of which is more than n years old, and $1/n$ of which is of the latest design from every viewpoint.

OF the utmost importance, should any war or situation such as we have faced in Korea be forced upon us, we will have on hand and ready for immediate production, designs for military equipment which are as modern and up to date as can possibly be conceived.

There are a number of other factors which must be borne in mind in the consideration of this problem. During World War II we heard and read a lot about the so-called "Industry-Ordnance Team," and it is freely acknowledged that our tremendous wartime production was due, in no small measure, to the close coöperation and collaboration which that relationship made possible.

For industry to make a profit, efficiency and economy are primary considerations.

In the military world, effectiveness is of paramount importance, and military effectiveness is not necessarily synonomous with either industrial efficiency or commercial economy. Each one can learn from the other. Under the drive of commercial competition, industrial units must advance and improve technically in order to survive. These improvements and advances are many times of great value to military equipment.

Trained technicians examine barrels and receiver groups on rebuilt M1 rifles as part of the program to keep our troops well armed at all times (Army photo).

Conversely, frequently the Army has a requirement for and actually develops an item which proves to be of value to industry. A close partnership between the supply arms and services and the appropriate section of industry can be mutually effective and beneficial.

There is, perhaps, no industry in which this is of greater benefit than the automotive industry. It is particularly valuable in any time of peace to be able to give to industry a reasonably constant volume of military production in the automotive fields.

This keeps industry familiar with the Army's problems and requirements and keeps the Army up to date with industry's advances and improvements. Industrial know-how has solved many of the Army's problems and made possible the tremendous quantity production required in time of war. The closer this partnership in time of peace, the better we will be served in the days of peace and the quicker we can meet the demands of the days of war.

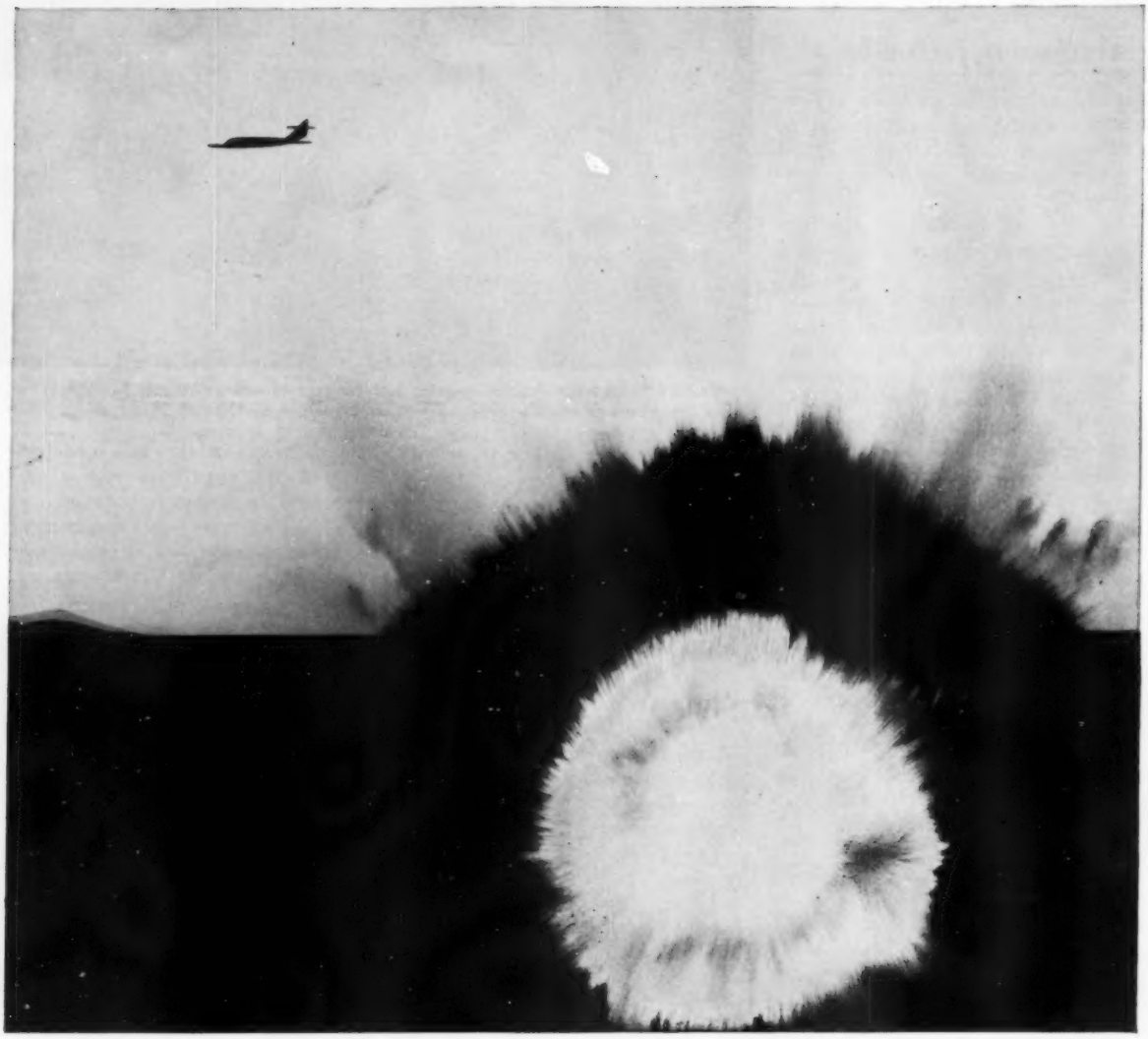
We must also give some thought to the type of contract by which this $1/n$ of our desired vehicles will be procured. This is especially true if any special-purpose machine tools are involved or any special processes in the development of which the Army has played a major rôle.

NO discussion of this subject would be complete without some mention of spare parts. Whenever a completely new item is produced, spare parts can be ordered only on the basis of a carefully engineered examination of the item in an effort to guess what parts may wear out first and how frequently.

However, once the item gets in the hands of troops and they have used that piece of equipment for a year or so, there will be ample information on which to build spare-parts requirements —and any consideration of production must include the spare parts' requirements.

TO summarize, it is believed that we can maintain an adequate instant supply of modern military equipment if the following steps are utilized:

1. Follow a program of maintenance and modification for the vehicles we may have on hand.
2. Keep our designers and engineers constantly at work on designs employing the latest technical advances and incorporating the latest military demands.
3. Restrict the number of types of military items to an absolute minimum.
4. Utilize to the utmost commercial components and subassemblies of proven merits.
5. Restrict service tests to investigations of military and tactical capabilities rather than technical characteristics.
6. Deny the use of strictly military vehicles to Zone of Interior installations.
7. Establish a reëquipment program with due consideration of the financial and military situation.
8. Procure vehicles on the basis of annual quotas in accordance with the program of Item 7 above.
9. Freeze designs during the construction of any and all annual procurement quotas.
10. Maintain the closest liaison with industrial automotive engineers and designers.
11. Provide for an adequate supply of spare parts.
12. Continue the Industry-Ordnance Team.



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JANUARY-FEBRUARY 1957

The following companies have shown by their interest in the design and production of ordnance that they are ready to serve the United States through industrial preparedness for national security and peace. Such companies as these are indicative of the industrial strength of the Nation upon which the military might of the armed forces depends.

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ORDNANCE *is set up, printed, and bound for the American Ordnance Association by the William Byrd Press, Inc., Richmond, Va.*

5 weeks after the order Perry Plastics delivered photo flash cartridge primers to Picatinny Arsenal

TODAY . . . AFTER 6 YEARS "NEAR-CONTINUOUS" OPERATION MOLD STILL PRODUCING

It takes a lot of light to brighten up the night sky for reconnaissance photography. It also takes the kind of precision that matches the speed of light. The M112 Photo Flash Cartridge does both dependably.

In the official photograph shown above you see a pattern made by setting off a series of these M112 Cartridges, each with a million and a half candle power.

The proper timing needed to insure a uniform light pattern is due in large part to the M59 Electric Primer which triggers a flash. It must respond accurately and precisely to the burst of electricity that energizes it. Note the uniformity of the light pattern in the photograph. It's perfect. Perry Plastics of Erie supplied Picatinny Arsenal with engineering quantities. Production runs in the millions to all Ordnance prime contractors for this photo cartridge.

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Unusual? No. Perry Plastics is staffed and equipped to handle exacting requirements like this in a wide variety of materials and processes. Our operation includes thermoplastics, thermosetting, fiber glass lamination and molded expanded polystyrene.

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PERRY PLASTICS, INC.

ERIE, PENNSYLVANIA

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The Terrier Clears the Air!

Convair's versatile Terrier missile is now seeing land duty with the U.S. Marine Corps—affording you *new* and *mobile* protection! Already operational at sea with the U.S. Navy, the Terrier's new mobility is provided by launchers and handling equipment developed specifically for ground use.

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Produced by **Convair-Pomona** in cooperation with the **U.S. Navy Bureau of Ordnance,** the Terrier now can clear the air from both land and sea for your protection!

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION

TWO HEADS ARE BETTER THAN ONE

It takes two experienced fliers—the pilot and the landing signal officer—to make a carrier landing. In the same way, two activities—creative engineering and production technique—work together at Arma to develop and produce advanced weapon control systems.

If you are interested in systems for *guidance* and *control*, contact Arma . . . Garden City, N. Y. A division of American Bosch Arma Corporation.

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